FM 23-85

DEPARTMENT OF THE ARMY FIELD MANUAL

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60-MM MORTAR, M19

HEADQUARTERS, DEPARTMENT OF THE ARMY
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FIELD MANUAL
No. 23–85

HEADQUARTERS
DEPARTMENT OF THE ARMY
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*This manual supersedes FM 23–85, 29 November 1950, including C 1, 16 October 1951, C 2, 22 August 1952, and C 3, 21 September 1956.

CHAPTER 1

INTRODUCTION

1. Purpose and Scope

a. This manual is a guide for personnel conducting training with the 60-mm mortar. It contains detailed information on mechanical training, crew drill, technique of fire, and fire control procedures.

b. Most of the equipment discussed is available in two or more different models; where there are substantial differences in the operation of two similar items, the differences are covered separately.

c. Crewmembers and commanders should become thoroughly familiar with the details on firing the 60-mm mortar. Proper care and maintenance of the weapon, careful handling of the ammunition, and correct and precise firing procedures are most essential to the safety of the mortar crew. For references, see appendix A.

d. The material contained herein is applicable without modification to both nuclear and nonnuclear warfare.

2. Recommended Changes

Users of this manual are encouraged to submit recommended changes and comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the Commandant, United States Army Infantry School, Fort Benning, Ga. 31905.

CHAPTER 2

MECHANICAL TRAINING

Section I. DESCRIPTION, NOMENCLATURE, AND FUNCTIONING

3. Characteristics and General Data

a. Characteristics. The 60-mm mortar, M19, is a smoothbore, muzzle-loaded, high-angle fire weapon. The mortar, hereafter referred to as the barrel, is assembled into a single unit. The mount consists of two units—the bipod and baseplate (fig. 1). The barrel is attached to the bipod by a clamp, and it is easily dismounted. It is fastened to the baseplate by inserting the spherical projection into the base cap socket and then closing the locking lever. The mortar may be used for direct fire missions by eliminating the bipod and substituting the small baseplate, M1, for the conventional baseplate. When this is done one man can operate the mortar. In this case the mortar is referred to in this manual as the handheld mortar. For a detailed list of the parts, equipment, and essential data for the mortar, see TM 9–3071–1 and supporting maintenance unit.

Figure 1. 60-mm mortar, M19, with M5 mount.

b. General Data.

Weights:	
Mortar, complete	45.2 lb.
Mortar, with M1 baseplate	20.5 lb.
Barrel	16.0 lb.
Bipod	16.4 lb.
Baseplate	12.8 lb.
Baseplate, M1	4.5 lb.
Overall length	32.25 in.
Elevations, approximate:	
With M5 mount (conventional).	40° to 85°; 710 to 1510 mils.
With M1 baseplate	0° to 85°; 0 to 1510 mils.
One turn of elevating crank, (approximate).	½°; 10 mils.
Traverse, right or left, (approximate).	125 mils.
One turn of handwheel (approximate).	15 mils.
Rate of fire:	
Maximum rounds per minute	30
Sustained rounds per minute	18
(Firing at the maximum rate of fire for more than one minute will cause gas leakage around the base cap.)	

Range

Maximum, approximate:

HE, M49A2 .... 1,790 meters
Smoke (WP), M302 .... 1,450 meters
Training practice, M50A2 . 1,790 meters
Training round, M69 ...... 225 meters
Illumination, M83A1 and A2. 1, 000 meters

4. The Mortar Barrel Assembly

The mortar barrel assembly (fig. 2) consists of the barrel and combination base cap and firing mechanism.

a. The *barrel* is bored smooth and carefully finished in interior dimensions and surfaces.

b. The *base cap* is hollowed and threaded to screw *on the barrel, thereby closing the breech* end of the barrel. The firing mechanism housing is attached to the base cap by a threaded adapter. The spherical *projection*, which fits into and locks into the socket of the baseplate, is a prolongation of the firing mechanism housing.

c. The *firing mechanism* consists mainly of a firing pin, firing pin striker, firing spring, striker pawl, trigger, and firing lever. A *firing selector*, which acts as a cam on the rear end of the firing pin striker, permits the mortar to be fired with or without the firing lever.

5. The Bipod

The *bipod* (fig. 3) consists of the leg assembly, elevating mechanism assembly, and traversing mechanism assembly.

a. The *leg assembly* consists of two tubular steel legs connected by a clevis joint that is attached by two bearings (front and rear) to the elevating screw guide tube. The clevis joint limits the spread of the legs. Each half of the clevis joint is pro-

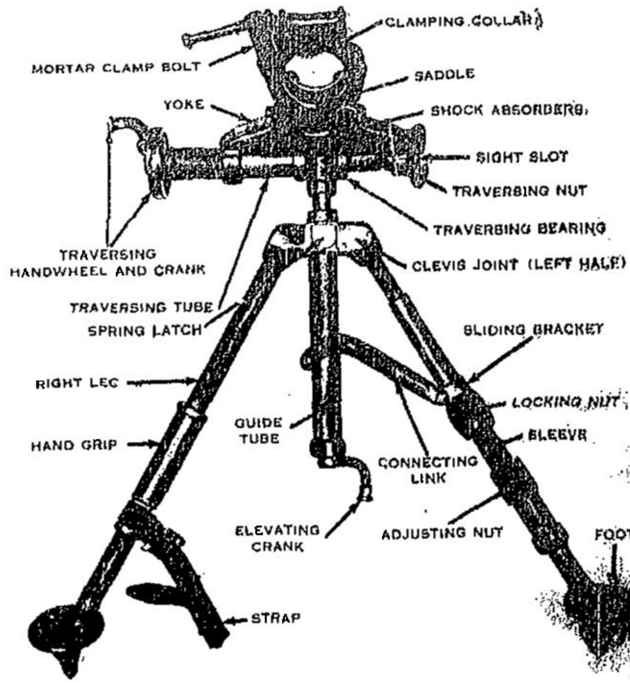


Figure 3. Bipod, M2.

vided with a spring latch to lock the legs in the open position. The legs terminate in spiked feet.

(1) The left leg has a cross-leveling mechanism that provides the gunner with a means of keeping the bubble in the cross-level of the sight centered. It is necessary to keep the sight cross-leveled. When the mortar is cross-leveled the barrel points in the desired direction. The cross-leveling mechanism consists of a sliding bracket, a sleeve, a locking nut, and adjusting nut, and a connecting link. The sliding

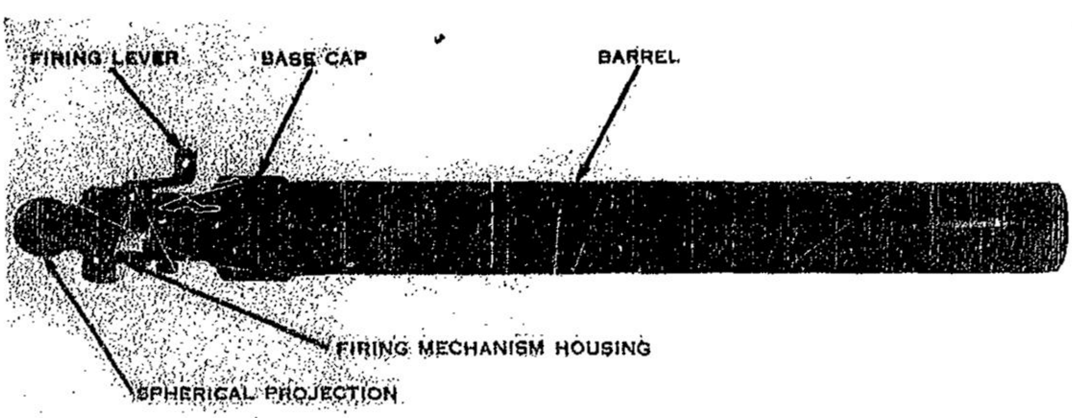


Figure 2. 60-mm mortar barrel assembly, M19.

bracket is mounted on the sleeve and locked in the desired position on the sleeve by the locking nut. The sliding bracket is also connected to the guide tube by the *connecting link*. The adjusting nut moves the sleeve up or down the left leg and transmits movement through the sliding bracket, connecting link, and guide tube to the yoke on which the sight is mounted. Thus, the bubble in the cross-level of the sight may be centered by moving the adjusting nut.

(2) The *right leg* contains no moving parts. On the lower part of the right leg is a leather handgrip and a strap to secure the legs to the barrel when the mortar is carried.

b. The elevating mechanism assembly consists of an elevating screwnut that moves vertically on a screw within the guide tube. The elevating screw is turned by the crank attached to its lower end. The upper end of the elevating screw fits into the lower end of the traversing bearing and is locked to it by a pin. The elevating screw remains within the guide tube when the elevating crank is turned. The elevating screwnut appears above the guide tube when the mortar is elevated.

c. The traversing mechanism assembly consists of the traversing mechanism, shock absorbers, and clamp.

(1) The *traversing mechanism* is a telescoping type of mechanism and consists of a tube and nut. Turning the handwheel causes the nut to move back and forth within the tube, thus moving the yoke and traversing the mortar. The yoke provides the bearings for the traversing mechanism and connects the mortar clamp and the elevating mechanism. The sight bracket fits into a dovetail slot in the yoke.

(2) The *shock absorbers* stabilize the mortar and mount during firing. They permit movement between the yoke and the clamp assembly and are countered by the resistance of two coil compression springs, which are mounted in the shock absorber retainers of the saddle.

(3) The *clamp* is in two sections and clamps the barrel to the bipod. The lower half is called the saddle and includes two shock absorber retainers with locking screws. The upper half of the clamp is called the clamping collar. The two halves of the clamp are hinged and can be locked tightly together by the clamp bolt. When secured about the barrel, they lock it firmly to the bipod. The clamping collar is placed around the barrel so that 10 inches of the barrel extends in front of the collar.

6. The Baseplate

The baseplate (fig. 4) is a pressed steel body to which are welded a series of ribs and braces, a front flange, and the socket. A locking lever is mounted on a pivot on the left of the socket to lock the spherical projection of the mortar in the socket. The base cap fits into the recess in the forward part of the baseplate when the entire mortar is carried as one unit.

7. The M1 Baseplate

The M1 baseplate (figs. 5 and 6) is a curved metal base with a ball socket shaped to receive the spherical projection. Part of the ball socket consists of a split nut that fits around the spherical projection and then screws into the socket on the baseplate to hold the spherical projection secure. A carrying strap may be fastened at one end to the stud on the baseplate. The other end of the strap is permanently attached to the muzzle cover.

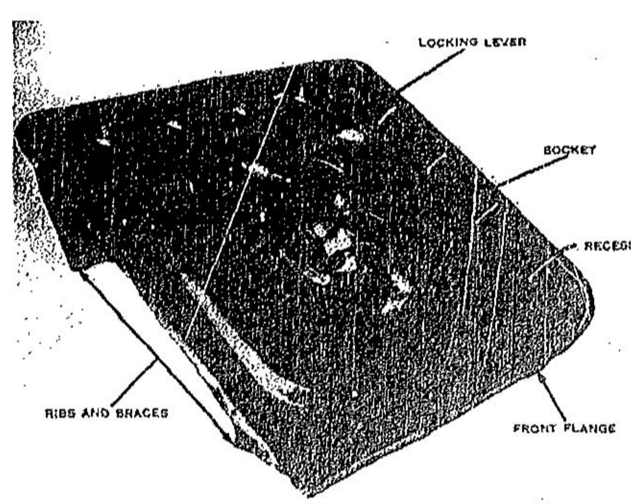


Figure 4. Baseplate, M1.

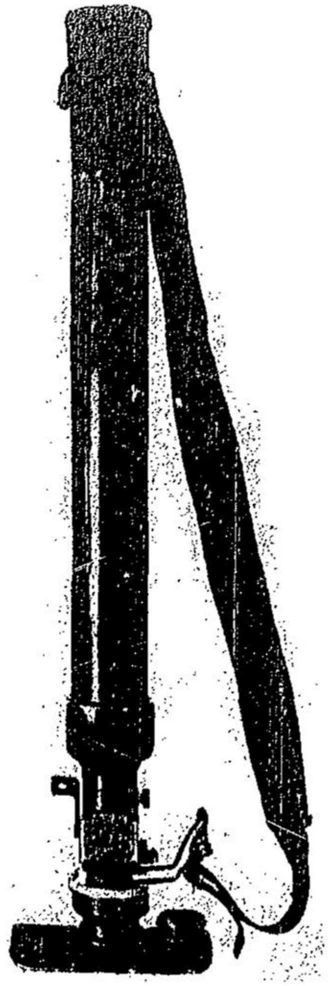


Figure 5. Handheld mortar assembled.

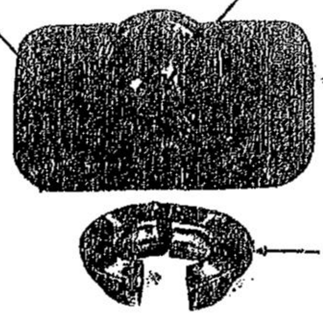


Figure 6. Baseplate, M1.

8. Functioning

The mortar is fired by inserting a complete round in the muzzle. The elevation of the barrel allows the round to slide toward the base of the barrel. When the firing selector is set on drop fire, as the round reaches the base, the primer of the ignition cartridge strikes the firing pin located inside the base cap. The flame from the exploding cartridge ignites the propelling charge. The gas pressure produced from the burning propellant drives the round up and out of the barrel, arming the fuze. When fired, the round carries the fired ignition cartridge case with it. The mortar is then ready for the next round. When the firing selector is set on lever fire, the lever is tripped to ignite the ignition cartridge after the round has come to rest against the base cap.

Section II. DISASSEMBLING, ASSEMBLING, MOUNTING, AND DISMOUNTING

9. Disassembling the Firing Mechanism

The mortar crew may disassemble the firing mechanism (fig. 7); however, this is the only part of the mortar disassembled by other than supporting maintenance unit personnel. Follow this procedure in disassembling and assembling the firing mechanism:

a. Remove the lock screw from the firing mechanism housing.

b. Unscrew in a counterclockwise direction the complete firing mechanism housing assembly from the base cap.

c. Remove the firing pin striker, firing spring, and firing spring stop.

d. Remove the housing cover pin by drifting it out to the left.

e. Push in on the selector plunger and remove the housing cover, firing selector, selector plunger and spring, firing lever, tripper, and firing lever spring and sleeve.

f. Taking up the barrel and base cap, remove the housing adapter by screwing it in a *clockwise* direction and allowing it to slide out the muzzle end of the barrel. (DO NOT UNSCREW THE BASE CAP FROM THE TUBE.)

g. Remove the firing pin assembly from the housing adapter by turning the firing pin bushing in a counterclockwise direction.

h. Remove the stop washer and retracting spring from the firing pin lock by pressing the firing pin lock against the action of the retracting spring until the lock slides out through the lock recess.

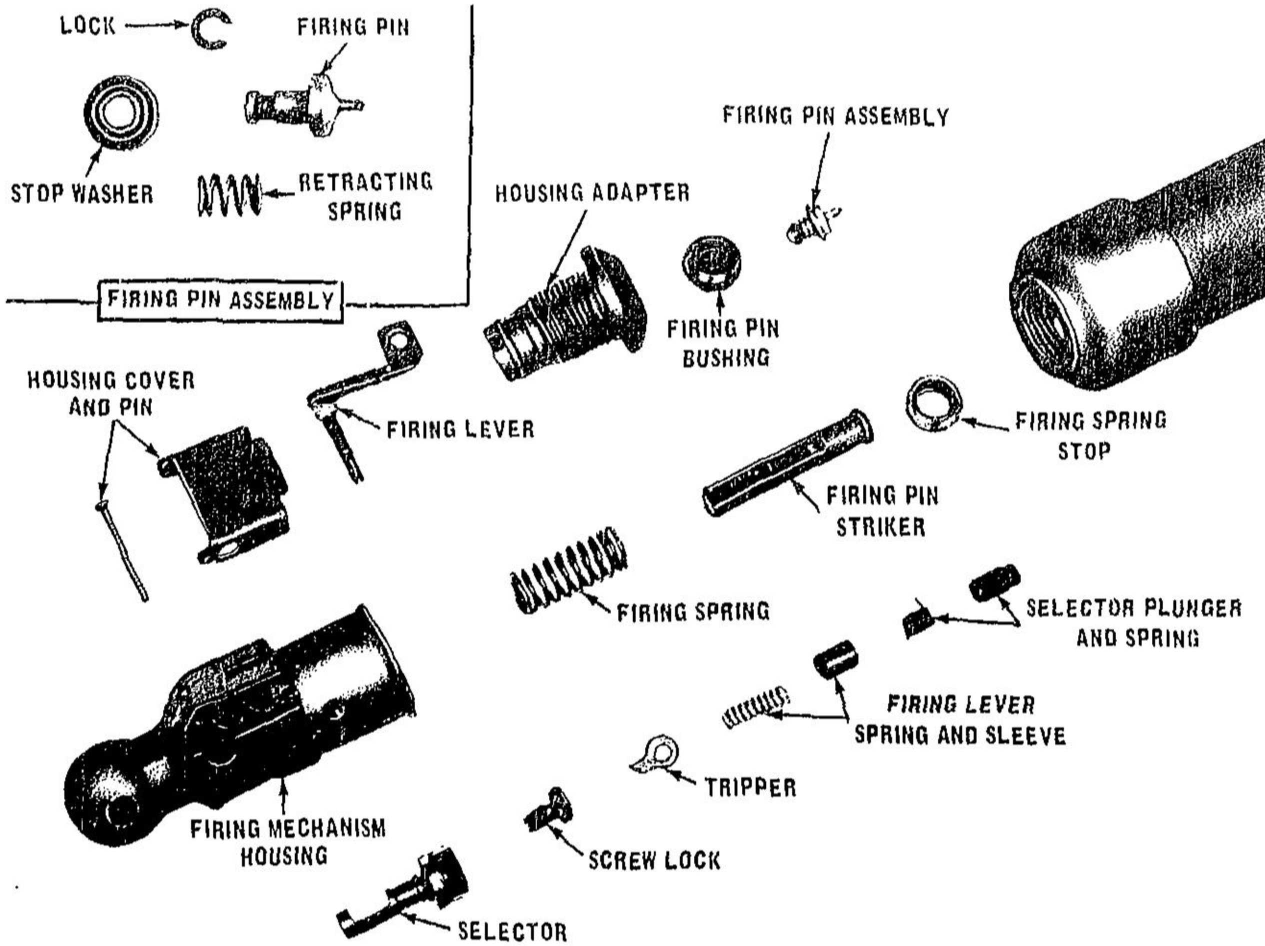


Figure 7. Firing mechanism.

10. Assembling the Firing Mechanism

Follow the procedure given in *a* through *j* below, for assembling the firing mechanism.

a. Place the stop washer and retracting spring on the rear shank of the firing pin and lock in place with the firing pin lock.

b. Place the firing pin assembly in the mushroom end of the housing adapter and secure the assembly by replacing the firing pin bushing. Set the bushing securely with the wrench provided for that purpose.

c. Replace the housing adapter in the base cap by sliding it down the barrel until the slotted collar protrudes from the base cap. Then screw it firmly into place in a counterclockwise direction.

d. Pick up the firing mechanism housing in the left hand with the raised square surface up and the spherical projection to the rear; replace the firing lever spring and sleeve in the upper forward hole in the right side of the housing.

e. Hold the tripper in the right hand with the point to the front and the flat cam surface up; position it in the rectangular hole in the flat surface of the housing by starting the pointed cam in first. Keep it pointed toward the front of the firing mechanism housing. While holding the tripper in place from the inside with the index finger of the left hand, replace the firing lever in the hole on the left with the lever arm up and to the front. Set the firing lever spring sleeve flush with the surface of the housing.

f. Replace the selector plunger and spring in the rear upper hole, and the firing selector in the lower hole on the right side of the housing.

g. Replace the housing cover and pin. The pin is drifted in from left to right. Press the selector

plunger in flush with the housing surface while replacing the housing cover.

h. Place the firing spring and spring stop on the striker. The spring stop sleeve must protrude beyond the face of the striker.

i. Place the striker in the housing with the groove in line with the tripper. Set the firing selector at LEVER FIRE and screw the complete firing mechanism housing assembly securely to the housing adapter in a clockwise direction.

j. Test the firing mechanism by tripping the firing lever. If it functions properly, replace the screw lock in the right side of the housing.

11. Functioning of the Firing Mechanism

The moving parts of the firing mechanism are within or attached to the combination base cap and firing mechanism assembly. The firing pin is assembled in the firing mechanism adapter. It is held in a retracted position by the retracting spring at all times except when the striker exerts pressure on the rear end of the firing pin. This pressure causes it to protrude $\frac{1}{20}$-inch beyond the surface of the firing pin bushing. As pressure is applied to the lever arm, the tripper forces the striker to the rear against the action of the firing spring until the cam surface becomes disengaged from the striker groove. The striker is released and shoots forward to strike the firing pin and thus fires the piece. When the firing selector is set at DROP FIRE the cam surface of the selector acts directly on the rear of the striker, forcing it forward, and holding it against the rear end of the firing pin. This causes the firing pin to remain extended $\frac{1}{20}$-inch beyond the surface of the firing pin bushing.

12. Replacing a Broken Firing Pin

Remove the firing mechanism adapter from the base cap, and unscrew the firing pin bushing from the adapter. Remove the broken firing pin, place the retracting spring, stop washer, and spring lock on a new firing pin, and assemble.

13. Mounting the Mortar

a. To mount the mortar, place it in a firing position with the baseplate on top of the ground. Loosen the ground surface with an intrenching tool so that the baseplate can be seated rapidly by the recoil of the first two or three cartridges. To mount the mortar on a steep slope or uneven ground, prepare a horizontal surface for the baseplate.

b. Kneel on the right knee at the left of the baseplate with the entire mortar resting on the ground and pointed in the general direction of fire. Unbuckle the leather strap, and grasp the mortar with the right hand at the midpoint of the barrel, and raise the unit until the bipod legs can be swung clear of the baseplate with the left hand. Allow the bipod legs to rest momentarily on the ground. Reach over the barrel with the right arm, grasp the legs with both hands just above the feet and pull the legs apart until the spring latch snaps into place. Position the baseplate so that the left front corner rests against the baseplate stake and the left edge of the baseplate is alined on the aiming stake. Next, place the traversing mechanism in a horizontal position by moving the guide tube to the right, turn the adjusting nut until the left index finger covers the unpainted surface of the leg below the adjusting nut, and tighten the locking nut. Then place the bipod legs about 18 inches in front of the baseplate, with the legs parallel to and centered on the front flange of the baseplate. Turn the elevating crank 15 turns to center the elevating screwnut, center the traversing mechanism, place the traversing crank in its operative position, and remove the muzzle cover. Mount the sight on the mortar; set the elevation scale at 62° or 1100 mils and the deflection scale at zero, and assume a sitting position. Move the bipod legs until the vertical line of the sight or collimator is alined approximately on the left edge of the aiming stake. Then center the longitudinal (elevation) level bubble, cross-level with the adjusting nut only, and lay accurately for direction by simultaneous operation of the traversing handwheel and the adjusting nut. Then check the lay for elevation.

14. Dismounting the Mortar

From a kneeling position, remove the sight, set the deflection scale at zero and the elevation scale at 40°, place the sight in the sight case, and latch the case. Replace the muzzle cover. Center the traversing mechanism and return the traversing crank to its inoperative position. Next, turn the elevating crank until the elevating screwnut is returned completely into the guide tube. Loosen the locking nut, and move the guide tube over against the left leg. (The locking nut is not retightened.) Lift the left leg and move it over against the right leg. Supporting the bipod with the left hand at the midpoint of the legs, reach around the barrel

with the right hand and lift the right front edge of the baseplate until the recess fits around the base cap. Then position the legs of the bipod under the baseplate, and allow the entire mortar to rest on the ground. Then fasten the leather strap to secure the bipod and the baseplate to the mortar

Section III. CARE, CLEANING, AND INSPECTION

15. Care and Cleaning

a. The crew performs the care and cleaning of the mortar and its accessories. Experience has shown that this weapon becomes unserviceable through lack of care rather than from use.

b. Dirt and grit accumulate in traveling or from the blast of the mortar in firing and form cutting compounds. Powder foulings settle between and on operating parts and attract moisture, prevent proper operation of moving parts, and hasten the formation of rust. Clean dirt, grit, and powder foulings from all parts at frequent intervals, depending upon use and service. If rust should accumulate, remove it from bearing surfaces carefully so that the clearances are not unduly increased. Use crocus cloth. *The use of coarse abrasives is strictly forbidden.* When the mortar is not in use, oil it properly and place it under cover.

16. Lubricants, Cleaning Agents, and Rust Preventives

a. The materials authorized and issued for cleaning and lubricating the mortar are—

(1) Optical lens cleaning compound.
(2) Cleaning compound, solvent: rifle bore cleaner.
(3) Abrasive cloth, al-oxide.
(4) Abrasive cloth, crocus.
(5) Petroleum corrosion preventive compound.
(6) Olive drab-green enamel.
(7) Technical ethyl alcohol.
(8) Automotive and artillery grease.
(9) General purpose lubricating oil.
(10) Lens paper.
(11) Mineral spirits paint thinner (used in lieu of drycleaning solvent).
(12) Synthetic resin enamel thinner.

b. Rifle bore cleaner is issued for cleaning the bore of the mortar after firing. This material possesses rust preventive properties and provides temporary protection against rust. For better protection, however, dry the bore immediately after cleaning with rifle bore cleaner and coat the metal lightly with special preservative lubricating oil. When frozen, thaw it out and shake it up well before using. During freezing weather, fill closed containers not more than three-fourths full, because full containers burst when the contents freeze.

c. Use a soap solution for cleaning the bore when rifle bore cleaner is not available. To prepare this solution, chip up one-quarter pound of issue soap and dissolve it in one gallon of hot water. This solution is better when used hot, but it can be used cold.

d. Special preservative lubricating oil has rust-preventive as well as lubricating properties, but it cannot be depended upon to provide protection from rust for long periods. Use it to lubricate (in normal temperatures) all moving parts and for short term protection of the bore against rust. Preservative action results partly from the oily film on the metal parts and partly from chemical combination of inhibitors in the oil with the metal. It protects the metal surfaces from rust though no appreciable film of oil is present on the metal parts. When used on moving parts it is necessary to maintain a thin film of oil to provide the necessary lubrication.

e. Lubricating oil for aircraft instruments and machineguns is the proper lubricant to be used in temperatures below 0° F. It is an extremely light oil that relies entirely upon maintenance of the oil film to protect metal surfaces from rusting. When it is used as a preservative, inspect the metal parts daily for rust. When rust is found, clean and coat them lightly with the oil.

f. Light rust preventive compound is issued for the protection of metal parts for long periods of time while the parts are boxed and in storage. It can be applied with a brush at temperatures above 60° F. However, the best method is to apply it hot, either by brushing or dipping.

g. Drycleaning solvent is a noncorrosive petroleum solvent that removes grease, oil, or rust preventive compound. *It is highly inflammable. Do not use it near open flames.* Smoking is prohibited where drycleaning solvent is used. Apply it with rag swabs to large parts and use it as a bath for

small parts. Dry the surfaces thoroughly with clean rags immediately after using the solvent. Wear gloves when handling the parts after cleaning to avoid leaving fingermarks, which are ordinarily acid and induce corrosion. Drycleaning solvent attacks and discolors rubber.

17. Cleaning Equipment

a. The equipment authorized and issued for cleaning and lubricating the mortar are—

(1) Chamber cleaning brush, M6.
(2) Cleaning staff, M9.
(3) Hand trigger operated oiler.

b. The M6 chamber cleaning brush consists of a steel wire core with bristles. This core is twisted in a spiral to hold the bristles in place. Use it to clean small holes and threads found in the firing mechanism assembly.

c. The M9 cleaning staff is a rod with a handle at one end and a slotted tip at the other end. The slotted tip provides a means for securing cotton waste or rags to the staff for cleaning and oiling the bore of the mortar.

d. The hand trigger operated oiler is used to lubricate and apply oil to flat surfaces that require oil but have no fittings. By adding the special adapter to the oiler, it can be used to apply oil to the flush-type fittings located on the bipod.

18. Care and Cleaning When No Firing is Done

This includes the care to preserve the condition of the mortar during the time when no firing is being done. Mortars and accessories in the hands of troops are inspected daily to check their condition and cleanliness. Training schedules should allow time for supervised cleaning on each day the mortars are used.

a. To clean the bore, attach rags to the cleaning staff and insert the rags into the bore at the muzzle end. Move the staff forward and backward several times and replace the rags. Then push the staff forward until the rags touch the bottom of the bore, and twist the staff several times to the right. This cleaning removes accumulations of dust, dirt, and oil in the bore. Repeat until the rags come out clean. After the bore has been thoroughly cleaned, saturate clean rags with oil and push it through the bore.

b. To clean the firing mechanism, disassemble, and clean all parts thoroughly with rags. When cleaning the firing mechanism housing, make sure that all the holes and slots are cleaned. Use the M6 brush or a small stick wrapped with rags to clean the screw threads, holes, and crevices. After cleaning parts, saturate clean rags with oil and apply a thin coat of oil to every part of the firing mechanism. Inspect the threads on the firing mechanism adapter and the firing pin bushing to make sure that no lint is present. Then assemble the firing mechanism to the barrel.

c. Keep all parts of the bipod and baseplate clean and free from foreign matter. Keep all moving parts and polished surfaces coated with oil. To clean the screw threads and crevices, use a small brush or small stick. To clean the metal surfaces, rub them with a dry cloth to remove moisture, perspiration, and dirt. Then wipe them with a cloth wet with a small quantity of oil. Maintain this protective film at all times. For oiling the bipod, use the oiler with adapter to apply special preservative lubricating oil to the five flush-type fittings: left leg clevis, traversing bearing, sight slot on the yoke, and left and right shock absorbers.

19. Preparatory to Firing

Before firing—

a. Dismount the main groups.

b. Clean the bore and firing mechanism with clean, dry rags. Do not apply any oil to the bore before firing.

c. Clean and oil lightly all metal moving parts with oil. Do not use grease.

d. Mount the mortar for firing.

20. After Firing

Clean the mortar bore thoroughly by the evening of the day on which it is fired, because firing causes powder and primer fouling to collect in the bore and on the firing pin. This fouling absorbs and retains moisture from the air, thereby causing rust. Remove these deposits by cleaning with rifle bore cleaner, soap solution, or water.

a. Cleaning Procedure After Firing.

(1) Clean the bore, firing mechanism and all working parts on the mount. If this cannot be done at once, apply oil carefully to prevent rust.

(2) At the first opportunity, clean, oil, and inspect all parts and make needed repairs and replacements.

(3) On assembly, check the operation of the firing mechanism and bipod to make sure that functioning is correct.

b. Cleaning the Bore With Rifle Bore Cleaner.

(1) Remove the firing mechanism and adapter.

(2) Attach clean rags to the cleaning staff, saturate the rags with rifle bore cleaner, and push it back and forth through the barrel with the cleaning staff.

(3) Repeat the operation with clean rags two or three times. Be sure the rags go all the way through the bore before the direction is changed.

(4) Continue to swab the bore with quantities of clean, dry rags until the rags come out clean and dry.

(5) Examine the bore carefully for cleanliness. If it is not free of all residue, repeat the cleaning process.

(6) Secure a small piece of rag saturated with rifle bore cleaner, and thoroughly clean the threaded adapter recess in the base cap.

(7) When the bore and adapter recess are both thoroughly clean and dry, apply oil to them with rags.

c. Cleaning the Bore With Soap Solution.

(1) If rifle bore cleaner is not available, use soap solution or plain water.

(2) Clean the bore and adapter recess using a liberal quantity of soap solution in place of the rifle bore cleaner.

(3) Rinse the barrel with clean water to remove the washing material.

(4) Dry the barrel by using clean rags. Swab the bore thoroughly until it is dry and clean.

(5) When the bore and adapter recess are clean and dry, saturate rags with oil and push it through the bore. Oil the adapter recess, but make sure that no lint is left on the threads.

d. Cleaning the Firing Mechanism.

(1) Disassemble the entire firing mechanism (para. 9).

(2) Clean the firing mechanism adapter and firing pin with rifle bore cleaner, or whichever cleaning agent is available to remove the primer and powder fouling.

(3) Clean all other parts of the firing mechanism with drycleaning solvent, using the M6 brush or a small stick covered with rags to remove dirt from the recesses.

(4) After all parts have been cleaned and dried, saturate clean rags with oil and apply a thin coat of oil to every part of the firing mechanism.

(5) Assemble the firing mechanism, being sure that no lint remains on the thread of the firing mechanism adapter or on the firing pin bushing.

Note. The heat from firing dries the oil on the working parts of the firing mechanism and may cause the mechanism to become sluggish or fail to function during firing. When this happens take the mechanism apart, and clean and oil it.

e. Cleaning the Mount.

(1) Wipe the bipod clean, taking care to remove dirt from all crevices. Clean all moving parts with drycleaning solvent. Use the cleaning brush or a small stick covered with rags to remove dirt from all recesses.

(2) Dry all parts.

(3) Wipe all moving parts and polished surfaces with a cloth wet with oil.

(4) Apply oil to the five lubrication fittings.

(5) Operate the handwheel and cranks to distribute the oil over the working surfaces.

f. Cleaning Exterior Surfaces. To clean the exterior surfaces, wipe off the mortar with a dry cloth to remove dampness, dirt, and perspiration.

g. Caring for Accessories. Inspect, clean, and oil the accessories.

h. Cleaning the Mortar. Clean the mortar completely as soon as possible after firing. When the mortar is not to be fired on the following days, repeat the cleaning procedure as outlined for 3 days.

21. On the Range or in the Field

For maximum efficiency, observe the following points:

a. Do not fire a mortar with any dust, dirt, mud, or snow in the bore.

b. Keep the bore free from oil and dirt when firing.

c. Do not leave rags or other obstructions in the bore.

d. Keep the firing mechanism clean and well oiled at all times. When the firing mechanism or bipod shows a lack of lubrication and excessive friction, apply additional oil where needed.

e. Oil all sliding surfaces frequently and freely to insure perfect functioning of the mount.

f. If in an emergency and the prescribed lubricant is not available, use lubricating oil, or any clean, light, mineral oil similar to engine oil.

22. Preparation for Storage

a. Special preservative lubricating oil is the most suitable oil for short time protection of the mortar mechanism. It is effective for storage for 2 to 6 weeks, depending on climatic conditions. However, inspect mortars in short time storage every 5 days, and renew the preservative film, if necessary. For longer periods protect them with light rust compound. This is a semisolid material. It preserves the polished surfaces and the bore for 1 year or less, depending upon climatic and storage conditions.

b. Clean the mortar and prepare it for storage with particular care. Clean the bore, all parts of the firing mechanism, and the exterior of the mortar with drycleaning solvent. Dry them completely with clean cloths. Do not touch a metal part with your bare hands after drying it. Coat all metal parts with either special preservative lubricating oil or light rust preventive compound, depending on the length of storage required. Apply the rust preventive compound to the bore by dipping rags in the compound and running it through the bore two or three times with the staff. Disassemble the firing mechanism, then thoroughly coat it with rust preventive compound and reassemble it. Do not place a mortar in storage under any circumstances while it is contained in a cloth or other cover, or with the bore plugged. Covers collect moisture, which causes the weapon to rust.

c. Paint the wooden supports of the packing box with rust preventive compound before storing the mortar. Place the mortar in the wooden packing box, handling it with oiled rags.

23. Cleaning Weapons Received from Storage

Weapons that have been stored according to the previous paragraphs are coated either with special preservative lubricating oil or with light rust preventive compound. Weapons received from supporting maintenance unit storage are generally coated with rust preventive compound. Use drycleaning solvent to dissolve and remove all traces of this compound or oil. Clean all small parts and springs thoroughly. Failure to do this causes stiff or slow action because of the congealing of the rust preventive compound at low temperatures. This may possibly curtail proper functioning even at normal temperatures. After using this cleaning solvent, be sure to dry all parts by wiping them with dry cloths; then follow the instructions in paragraph 18. When drycleaning solvent is not available, remove the rust preventive compound by placing the mortar in boiling water for 12 minutes. Dry all parts thoroughly, and follow the instructions in paragraph 18.

24. Care and Cleaning in Cold Climates

Keep the moving parts of the weapon absolutely free from moisture. Lubricants or rust preventive compounds used in the temperate zones solidify in cold climates to the extent that they cause sluggish operation or complete failure.

a. To winterize the mortar, first remove all old lubricants and rust preventive compounds. Disassemble the mortar and use drycleaning solvent to clean all parts.

b. For lubrication, use lubricating oil for aircraft instruments and machineguns.

c. Before firing a mortar that has been used in deep snow, carefully check the bore to see that it is not clogged with snow, ice, or other foreign matter.

d. After firing, clean the bore with rifle bore cleaner in an alcohol solution.

e. The colder the climate, the less lubricant is used as there is less moisture in the air. In extremely cold climates, the lack of moisture in the air limits the possibility of the mortar rusting or corroding. However, exercise care to prevent snow or ice from collecting on the working parts.

f. Do not apply a lubricant to the mortar bore before operating the mortar in *extreme cold*. Cover all moving parts and machined surfaces other than the bore with a fine coating of lubricating oil. After firing, clean the mortar to make sure that ice and snow has not formed in any of the moving parts. Swab the bore with dry rags only to remove any snow or ice from the bore, particularly around the firing pin.

g. A heavy condensation forms on the mortar when it is taken from the extreme cold into any type of heated shelter. When brought indoors, first allow time for the mortar to come to room temperature. Then disassemble it, wipe it completely dry of the condensed moisture, and clean and oil

it thoroughly as described in paragraph 20. Use lubricating oil.

h. To avoid condensation, keep the mortar outdoors or store it in a lean-to after firing. However, if the weather changes abruptly (if it thaws suddenly or rains) use the normal cleaning methods.

25. Care and Cleaning in Tropical Climates

a. Where temperature and humidity are high, or where salt is present, and during rainy seasons, thoroughly inspect the weapon every day, and keep it oiled when not in use.

b. Keep unexposed parts and surfaces clean and oiled.

c. Use special preservative lubricating oil for lubrication.

26. Care and Cleaning in Hot, Dry Climates

a. In hot, dry climates, where sand and dust are likely to get into the mechanism and bore, wipe the weapons clean daily, or more often, if necessary.

b. When using the weapons in sandy terrain, wipe off all lubricants. This prevents the sand from sticking to the lubricant and forming an abrasive compound, which ruins the mechanism.

c. Immediately upon leaving sandy terrain, relubricate the weapon with light preservative lubricating oil.

d. Frequently wipe the metal parts dry, because sweat from the hands contains acid and causes rust.

e. During sandstorms or duststorms, keep the muzzle covered whenever possible.

27. Care During Gas Attack

a. It is important to prevent the chemical agents used in a gas attack from getting in or on the mortar and ammunition. Therefore, when a gas attack is anticipated, take steps to cover and protect the mortar, ammunition, spare parts, and accessories.

b. Put oil on the surfaces of all parts of the weapon, ammunition, and spare parts.

c. If the mortar is not used during the gas attack, cover the oiled weapon with covers or place it in a container so that it cannot come into contact with any contaminating chemical agents.

d. After the attack, if the weapon has not been contaminated, clean it with drycleaning solvent.

e. Prepare it for use as described in paragraphs 18 or 19.

28. Decontamination

a. When performing emergency decontamination, wear the issue protective mask and apply protective ointment to the hands and exposed skin surfaces. If permeable protective clothing is available, wear the standard set provided and the protective mask. Impermeable protective suits and rubber gloves are required only when handling heavy contaminated material.

b. Decontaminate mortar, accessories, and ammunition by blotting all liquid agents with rags and paper, wiping off grease and oil, and applying protective ointment to all areas that must be touched or handled when firing the weapon. To prevent corrosion, oil the metal surfaces (except for ammunition). When the tactical situation permits, carry out thorough decontamination. Use warm water and soap, solvents, and military decontaminants like DANC solution and bleaching material as prescribed in TM 3–220.

29. Painting

a. Retouch the mortar as needed, because rust forms on the mortar where the paint is worn away.

b. After a certain amount of retouching, the whole mortar needs repainting. To repaint, remove the old paint and primer with paint remover or by scraping. Smooth over all rust spots with emery cloth.

c. Clean and dry the parts thoroughly before repainting.

d. Apply two coats of primer on the bare metal as a base coat for the paint. Apply the primer by brushing or spraying; thin the primer for spraying. Let each coat dry 24 hours.

e. Apply two coats of lusterless, olive drab paint. Allow each coat to dry 24 hours.

f. The using units apply paint (and primer) to the following parts only:

(1) Entire baseplates.
(2) Barrel (except bore).
(3) Feet and right leg of bipod.
(4) Ordnance paints all other parts.

30. Inspection

When inspecting the mortar, observe the following points:

a. *Barrel*. Check general appearance and cleanliness of the bore.

b. *Firing Mechanism*. Examine for fouling, rust, or foreign substance on any of the parts. Trip the

firing lever so that the striker moves forward and strikes the base of the firing pin when the selector is on LEVER FIRE. The firing pin should protrude $\frac{1}{20}$-inch beyond the surface of the firing pin bushing when the firing selector is on DROP FIRE.

c. Bipod. Check general appearance and see that all moving parts are lubricated.

(1) *Elevating mechanism.* Elevate and depress the mortar to see that the mechanism operates without binding, excess play, or undue looseness.

(2) *Traversing mechanism.* Traverse the mortar to see that the mechanism operates smoothly without binding or undue looseness.

(3) *Cross-leveling mechanism.* Operate the mechanism to see that it functions correctly without excess play. Check the index marks (for centering the bubble) to see that they are distinct.

d. Baseplate. Check general appearance. Examine the locking lever to make sure that it operates easily and locks the spherical projection securely to the baseplate.

e. Sight and Mounting. Check to see if the operating condition of the sight or rigidity of its mounting has been impaired.

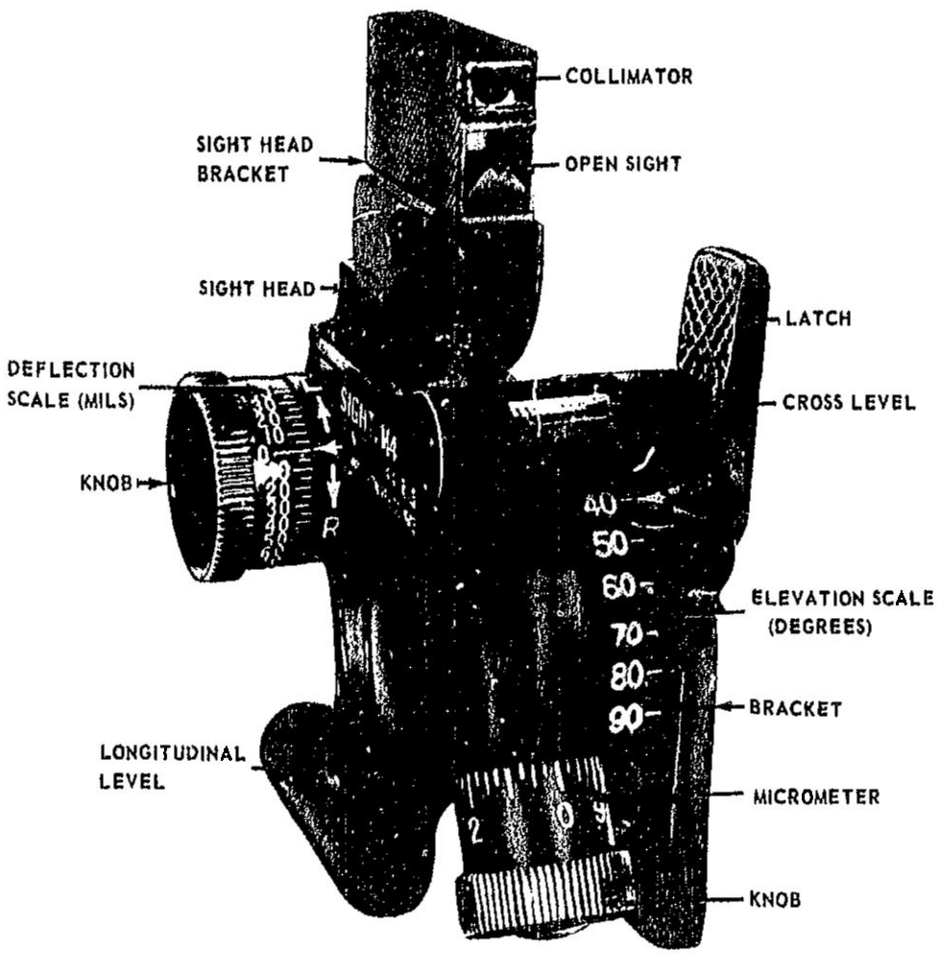


Figure 8. M4 sight.

31. M4 Sight

a. The M4 sight (fig. 8) is the standard sight for laying the mortar for elevation and direction. The sight includes a collimator, elevating and lateral deflection mechanisms, and longitudinal and cross-levels. All are supported by a bracket with a dovetailed base that fits into a slot in the mortar yoke and latches in place. An open sight is also provided, but is only used when the collimator is broken. The micrometer knobs and the deflection and elevation scales indicate deflection and elevation when the bubbles in the levels are centered. The collimator is the direction sighting device of the sight and consists of a vertical white line in an opaque field, all inclosed within a rectangular tube. When the sight is level, the white line of the collimator measures the same deflection between the line of sight and the direction of fire as is indicated on the deflection scale of the sight. The bracket upon which the collimator and open sight are mounted can be depressed or elevated so that the assembly can be moved in elevation to bring the aiming point into the field of view. This motion has no effect on elevation setting.

b. The deflection scale has 60 graduations, each representing 5 mils. The graduations are numbered every 10 mils from 0 to 150 on each side of the 0 position. Directions for turning the knobs for left and right deflections are indicated by the letters L and R and arrows near the index. When a deflection of 0 is placed on the sight, the line of sight is parallel to the direction of fire. The elevation scale is graduated into 6 divisions, each one representing 10°. The graduations are numbered from 40 to 90. The elevation micrometer is graduated into 40 divisions, each one representing ¼°. The graduations are numbered every 4 divisions (1°) from 0 to 10. The collimator and the open sight directly below it have vertical reference lines and can be placed as desired in elevation. When the sight head bracket is tilted to its extreme upward (rear) position and an elevation of 40° is placed on the sight, the elevation of the overhead portion of the open sight is 2° below the axis of the mortar barrel. This is an important feature when determining the approximate minimum elevation for clearing nearby objects.

32. Operation of M4 Sight

a. Attaching Sight. See paragraph 31*a* for procedure for attaching the sight.

b. Setting Sight for Deflection.

(1) Deflection is placed on the sight before elevation. To place a *right* deflection on the sight, *pull* the deflection knob (in the direction of the arrow pointing toward R) until the arrow pointing at the scale is opposite the selected deflection. To place a *left* deflection on the sight, *push* the knob (in the direction indicated by the arrow pointing toward L) until the arrow pointing toward the scale is opposite the selected deflection. Setting a deflection on the deflection scale (for example, a left deflection) moves the vertical line of the collimator in the opposite direction (right) (fig. 9).

Note. Figure 9 is a drawing of the Williams Sighting and Laying Device. It is a simple training aid that can be easily constructed by mortar units and used in gunner training to illustrate such points as the relationship between the line of sight and the direction of fire, referring the sight, placing additional aiming stakes, etc.

(2) The deflection placed on the sight is the deflection announced in the fire command. For example, the sight is set at left 10. The deflection is announced as RIGHT 50 in the fire command. The gunner places right 50 on the sight.

c. Setting Sight for Elevation. Place elevation on the sight *after* the deflection if there is a deflection change. To set the sight for elevation, turn the elevation knob which, in turn, operates both the elevation and micrometer scales. Thus both scales must be set correctly to obtain the desired elevation. For example, to place an elevation of 65° on the sight, turn the elevation knob until the arrow opposite the elevation scale is midway between the 60° and 70° marks and the 5° on the micrometer scale is opposite the micrometer scale index arrow. Use care to prevent making a 10° error; for instance, setting the elevation scale at 55° or 75° in the above example.

d. Removing Sight. To remove the sight, depress the latch to release the bracket and withdraw the sight. For traveling, set the elevation scale at 40° and place the sight in the carrying case.

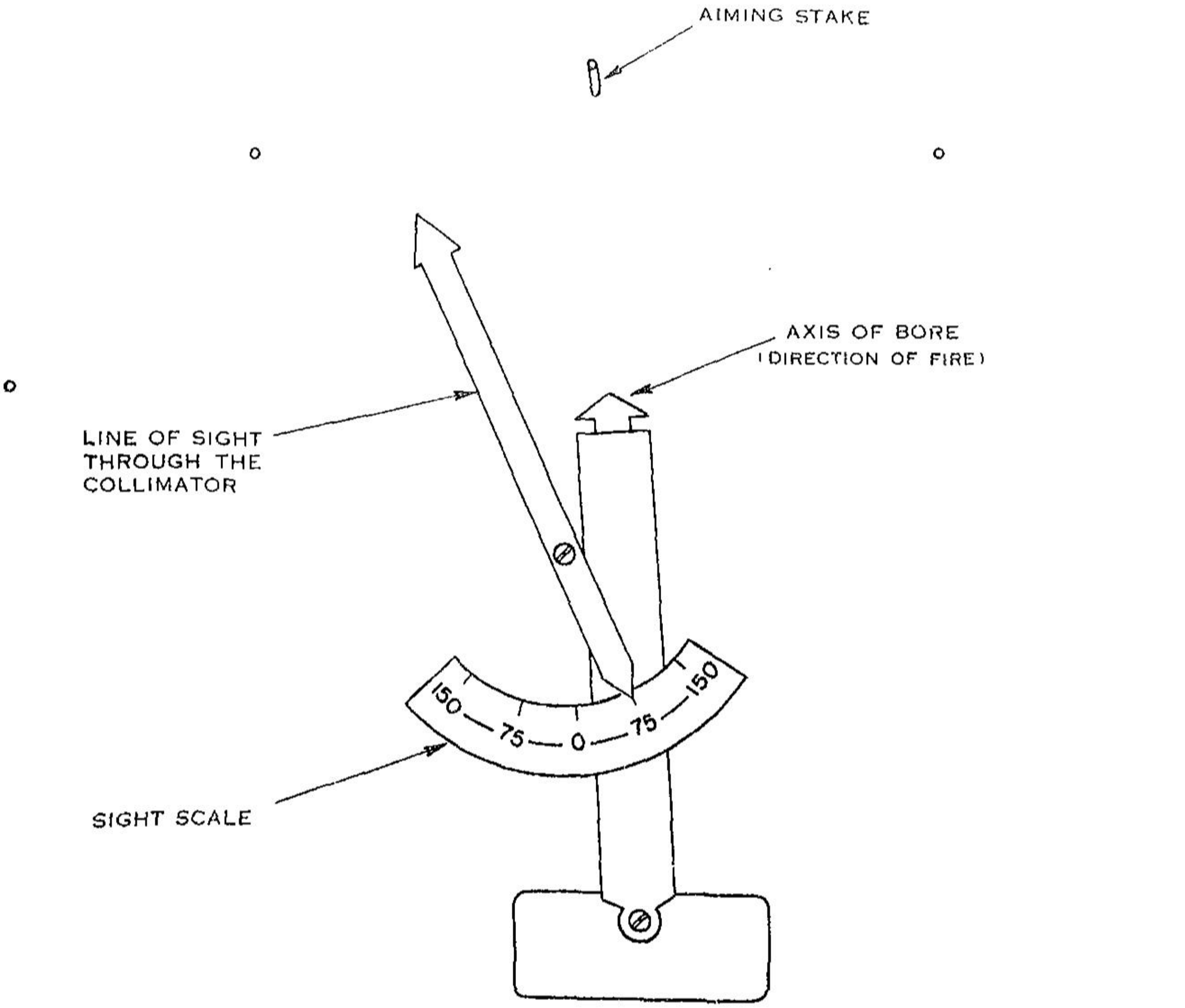


Figure 9. Sight setting does not change direction of barrel.

33. Maintenance of M4 Sight

Alinement of the levels, pivots, and collimator is made at the factory. Calibration of the deflection and elevation scales is accomplished by supporting maintenance unit personnel. Ordinarily, no facilities are available for verification in the field; therefore, adjustment is not permitted by the user. See paragraph 34 for general precautions to be observed when using this sight.

34. Care and Preservation of the M4 Sight

When using this sight, observe the following precautions:

a. Avoid striking or otherwise damaging any part of the sight. Do not burr or dent the dovetail bracket. Avoid jarring the micrometer knobs and telescope adapter.

b. Keep the sight in the carrying case when not in use. If the sight becomes wet, dry it thoroughly before placing it in the carrying case.

c. If the sight fails to function properly, turn it in to the appropriate supporting maintenance unit facility for repair. Members of the mortar crew are not authorized to disassemble the sight unit.

d. Keep the lens clean and dry. Use only lens cleaning tissue to wipe the lens. Never use ordinary polishing liquids, paste, or abrasives on optical parts. For removing grease or oil from the lens, use only the authorized lens cleaning soap.

e. Periodically oil the moving parts with light preservative lubricating oil (PL). To prevent accumulation of dust and grit, wipe off excessive lubricant.

35. Calibration of the M4 Sight Using the M45 Boresight

a. General. The M45 boresight device (fig. 10) consists of an elbow telescope, a telecope clamp, a body, two strap assemblies, and a clamp assembly.

(1) The elbow telescope establishes a definite line of sight.

(2) The telescope clamp maintains the line of sight in the plane described by the centerline of the V-slide.

(3) The body incorporates two perpendicular V-slides. It contains level vials to determine the angle of elevation (preset at 45° or 800 mils), and to determine that V-slides are in perpendicular positions. It also provides the hardware to which the strap assemblies are attached.

(4) Two straps are supplied with each boresight and are marked for cutting to the size required for any mortar.

(5) The clamp assembly applies tension to the strap assemblies to secure the boresight against the mortar barrel.

b. Principles of Operation. The boresight is constructed so the telescope line of sight lies in the plane established by the centerline of the V-slide. When properly secured to a mortar barrel, the centerline of the contacting V-slide is parallel to the centerline of the barrel. The cross-level vial, when centered, shows the centerline of both slides, the elbow telescope, and the barrel lie in the same vertical plane. Therefore, the line of sight of the telescope coincides with the axis of the barrel regardless of which V-slide is in contact with the barrel. The elevation vial is constructed with a fixed elevation of 45°.

c. Installation.

(1) Remove the boresight, clamp assembly, and straps from the carrying case. Grasp the boresight by the body to prevent damaging the telescope.

(2) Place the ring over the hook and attach the strap snap to the eye provided on the strap shaft.

(3) If necessary, release the catches and reset the straps to the proper length.

(4) Remove any burrs or imperfections from the seating area of the mortar barrel to insure proper seating of the boresight device. Position the device at the top of the mortar barrel as shown in figure 10.

d. Calibration for Elevation. Mount the mortar on level ground with a deflection of zero and an elevation of 45°. Make sure both level vials are centered.

(1) Install the boresight as in *c* above. Center the cross-level vial by rotating the device around the mortar barrel until the bubble is centered. Slight movements may be made by loosening the clamp screw and tapping the body of the boresight. When the cross-level bubble is centered, tighten the clamp screw.

(2) Elevate the mortar barrel until the elevation level vial bubble of the foresight is centered. The barrel is now at an elevation of 45°.

(3) Turn the elevation knob of the mortar sight until the elevation level vial on the sight is centered.

(4) Recheck all level vials.

(5) If necessary, adjust the elevation micrometer of the mortar sight to a reading of zero by loosening the retaining screws and slipping the micrometer. Check the elevation scale. It should read 45°. If it does not, loosen the retaining screws and slip the scale until the index is opposite the 45° graduation. Retighten all retaining screws. The mortar sight is now calibrated for elevation.

(6) To verify the accuracy of the elevation calibration, rotate the boresight 3200 mils around the mortar barrel as shown in figure 11. Center the cross-level vial by slight movements of the device. Check the elevation level vial; the bubble should once again be centered. If it is centered correctly, the elevation mechanism of the boresight is accurate. In verifying the elevation accuracy, care must be taken to insure the mortar barrel is not disturbed when positioning the boresight on the underneath portion of the barrel.

e. Calibration for Deflection. Install the boresight as in *d*(1) above. The mortar should be laid at a deflection of zero and an elevation of 45°.

(1) Traverse the mortar, cross-leveling simultaneously, until the vertical line of the boresight telescope is laid on an aiming point at least 100 yards (meters) distant.

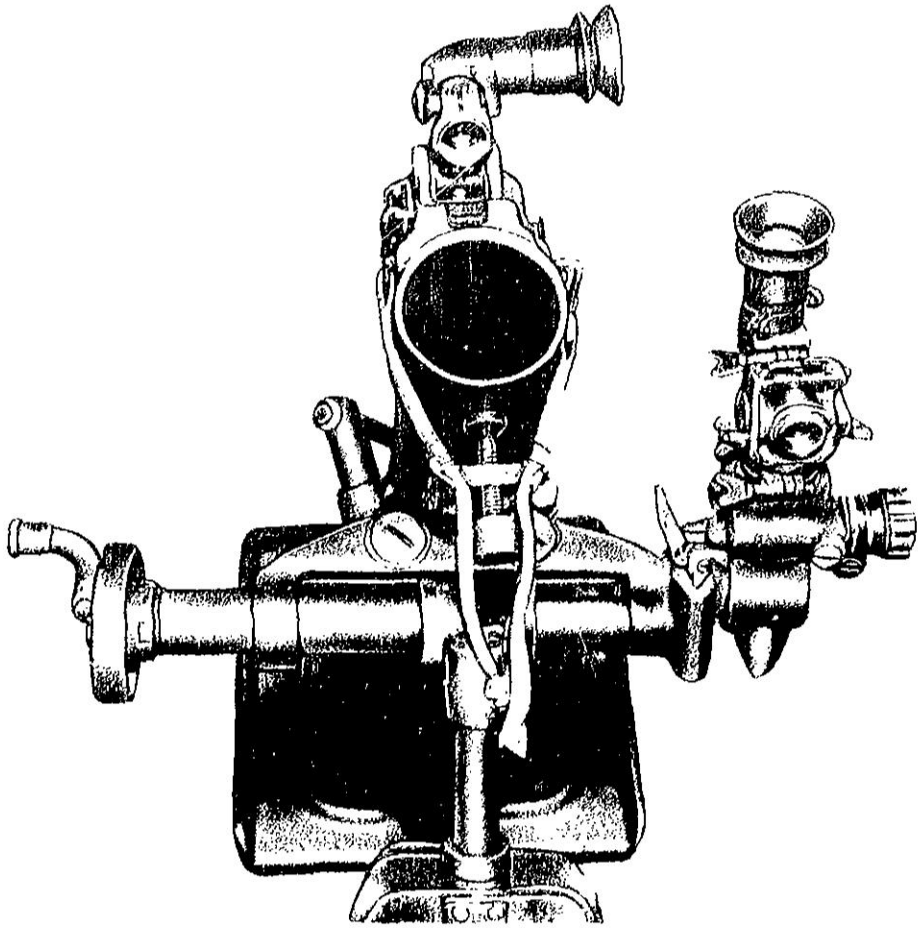


Figure 10. M45 boresight mounted on upper portion of barrel.

Check the level vials on the boresight and the mortar sight. All bubbles must be centered. Aline the vertical line of the mortar sight on the same aiming point by referring the sight (turning the deflection knob). If the deflection micrometer does not read zero, push in on the retaining button and slip the micrometer until the index is opposite the zero mil graduation. The deflection scale should also read zero. If it does not, loosen the deflection scale retaining wingnut and slip the scale until the index is opposite the zero graduation. Tighten the deflection scale retaining wingnut. The mortar sight is now calibrated for deflection.

(2) To verify the accuracy of the deflection calibration and the initial alinement of the mortar barrel, install the boresight on the underneath portion of the barrel as shown in figure 11. Do not disturb the lay of the mortar barrel while centering the cross-level vial bubble on the boresight. The vertical line of the boresight should once again be on the original aiming point. If not on the same aiming point, the true axis of the mortar barrel lies halfway between the original aiming point and the point at which the vertical line is now laid. When this situation exists, the mortar sight must be calibrated on a point midway between the original aiming point and the new line of sight since this is the true axis of the mortar barrel. This procedure verifies the accuracy of the device and at the same time corrects for cant of the mortar barrel.

f. Removal.

(1) Loosen the clamp screw, releasing the boresight from the mortar.

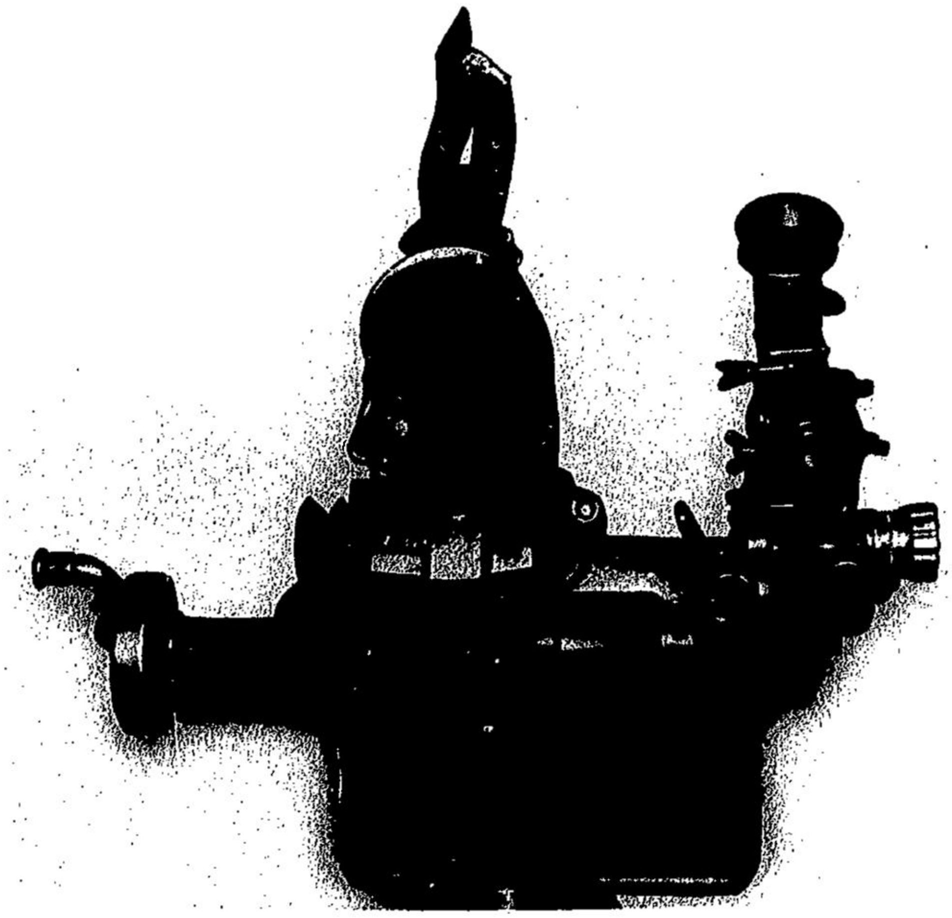


Figure 11. M45 boresight mounted on the underneath portion of barrel.

(2) Rotate the elbow telescope until it is approximately parallel with the elevation vial.

(3) Release the clamp assembly and strips by removing the ring from the hook and the strap snap from the eye provided on the strap shaft.

(4) Stow the clamp assembly and straps in the corner compartment. Place the boresight in the center compartment of the carrying case.

36. Calibration of the M4 Sight for Elevation Using the Gunner's Quadrant

The following is the procedure for calibrating the elevation scale using the gunner's quadrant:

a. Mount the mortar on level ground, sandbagging it for stability, and center the traversing bearing.

b. With a gunner's quadrant, elevate the barrel to an elevation of 1,100 mils.

c. Cross-level the mortar by turning the adjusting nut.

d. Center the elevation bubble by turning the elevation knob on the sight unit.

e. If the reading of the elevation scale of the sight is not 62°, the same as an elevation of 1,100 mils, set on the gunner's quadrant, and the reading on the elevation micrometer is not 0, make the following adjustments:

(1) Loosen the two screws that fasten the elevation scale to the telescope mount, and slide the scale until the 62°-mark on the scale is opposite the index. Then tighten the screws.

(2) Loosen the three screws in the end of the elevation knob and, holding the knob in place, slide the elevation micrometer scale until the 0 is opposite the index. Then tighten the screws.

f. Recheck the readings of the gunner's quadrant and the sight. If the readings are not identical, repeat the procedure outlined above.

37. Calibrating the M4 Sight for Deflection Using the Aiming Circle Method

There are two methods for calibrating the sight for deflection—the aiming circle method, and the distant aiming point method. To calibrate the deflection scale by the aiming circle method—

a. Set up the aiming circle 25 meters in rear of the mounted mortar.

b. With the azimuth scale and micrometer of the aiming circle at 0, aline the center of the reticle on the center of the base plug of the mortar.

c. Depress the mortar barrel to its lowest elevation.

d. Traverse and cross-level the mortar until the center axis of the barrel from the base plug to the muzzle is alined with the vertical line of the aiming circle telescope reticle.

e. Turn the deflection knob of the sight until the vertical line is centered on the lens of the aiming circle and read angle A, opposite the fixed index.

f. Turn the azimuth knob of the aiming circle until the vertical line of the telescope is laid on the center of the sight lens and read angle B, opposite the azimuth scale index. If the sight is in calibration, the angles will be equal. If they are not equal, the sight is adjusted as follows:

(1) With the deflection knob held in place, push in on the micrometer knob retaining button and slide the deflection micrometer scale until the last two digits of angle B are set at the micrometer index. Relock the retaining button.

(2) If the vertical line of the sight has moved off the center of the lens of the aiming circle telescope, repeat the steps outlined above.

(3) After the deflection micrometer has been corrected, check the setting on the deflection scale to see if it corresponds to the first two digits of angle B. If the digits do not correspond, loosen the deflection scale retaining wingnut and slide the scale to the approximate correct position.

(4) To obtain exact synchronization between the deflection micrometer and the deflection scale, turn the deflection knob *forward* to a setting of zero. Slide the deflection scale to zero and tighten the wingnut.

38. M34A2 and M53 Sight Units

The M34A2 and M53 sight units can also be used for laying the 60-mm mortar for deflection and elevation. The same sight should always be used with the same mortar. The sight units consist of a telescope mount, an elbow telescope, and a telescope adapter. For a detailed explanation of the operation of these sights, see FM 23-90 or FM 23-92.

39. Aiming Posts

Two M1A1 aiming posts are provided for the mortar. When placed out properly, these posts establish a reference line enabling the gunner to lay the mortar in the desired direction of fire. In addition, the unit may be equipped with the M7 or M10 aiming post for use as a direction post. In an emergency, any clearly defined object such as a tree trunk or the corner of a building can be used as an aiming point for a single mortar.

40. M37 Instrument Light

The M37 instrument light (fig. 12) is used with the M4 sight for night firing. It consists of a battery case with a built-in rheostat for controlling the degree of illumination of the collimator; a single cell 1½-volt battery, type BA-30, or equivalent; a hand light, a collimator light, and a clamp for attaching the case to the right bipod leg. The hand light is used to illuminate the scales and levels of the sight. When the hand light is not in use, it is mounted on the clip on the battery case. To lay the mortar, turn on the collimator light. This causes the white line of the collimator to become visible. Then lay the white line of the collimator on the thin green (red) vertical line of the aiming post light.

41. Aiming Post Light

For night firing, the M14 aiming post light (fig. 13) is used on an aiming post. It consists of a battery case which holds two flashlight batteries, a light bulb, and a switch. The light is provided with two colored filters, green and red, and a shaded hood. When the aiming post light is turned on, a thin green (red) light appears on the lens. When working with the M34A2 sight unit, in which a reference line is established by two aiming posts, the lights are staggered for ease in identification so that the gunners do not become con-

fused as to which posts are theirs. Each alternating mortar would have the red light on the far post to accomplish this effect.

42. Sight Extension

The sight extension is designed to permit the gunner to take up a prone position while laying the mortar. The extension has a bracket that fits into the sight slot on the mortar yoke, and a latch that holds it securely in place. When the extension is attached to the mortar, the M4 sight is inserted into a slot at the bottom of the extension. It is held in place by the sight latch. This slot is similar to the sight slot of the mortar. The overall length of the extension is approximately 8 inches.

43. Spare Parts and Accessorie.

a. Spare Parts. Parts will become unserviceable through breakage or wear. For this reason, spare parts are provided for replacement purposes. Sets of spare parts are kept complete at all times. The only spare part carried by the squad is an extra firing pin. The remaining spare parts are kept in the company arms or supply room.

b. Accessories. Accessories include the tools used for the maintenance of the mortar, tool rolls, chests, and other equipment necessary for storage and protection when the mortar is not in use or when traveling. Use the accessories for prescribed purposes only. When not in use, store them in the places or receptacles provided. Their names and general characteristics indicate their uses or application. Therefore, no detailed description or method of use is outlined in this manual. Accessories having special features or having special uses, however, are included as follows:

(1) *The M1 ammunition bag* consists of a single pouch and a shoulder carrying strap. It can be used to carry ammunition or the tool roll, firing tables, and flashlight.

(2) *The M2A1 ammunition bag* is a reinforced strip of canvas with pockets in the front and rear for the ammunition.

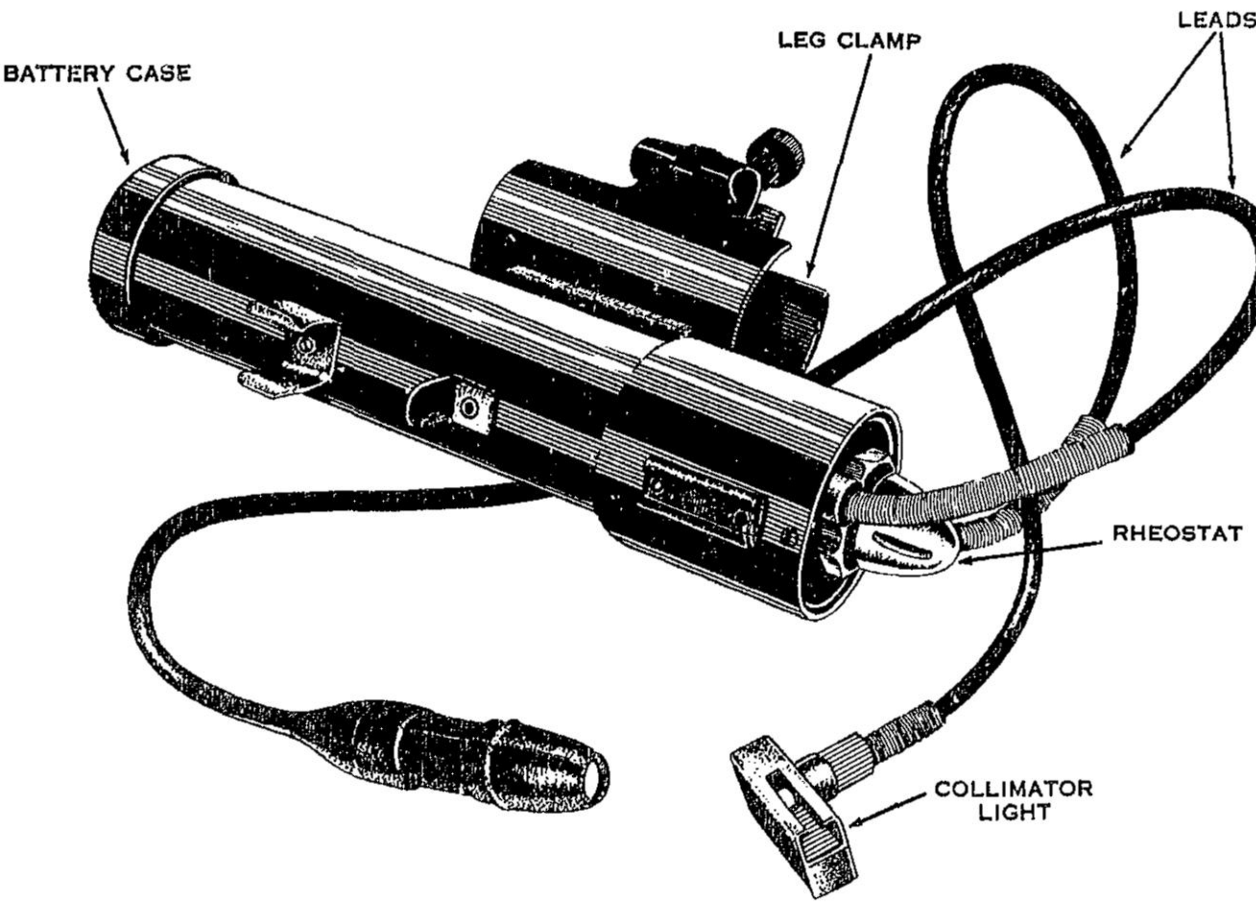


Figure 12. M37 instrument light.

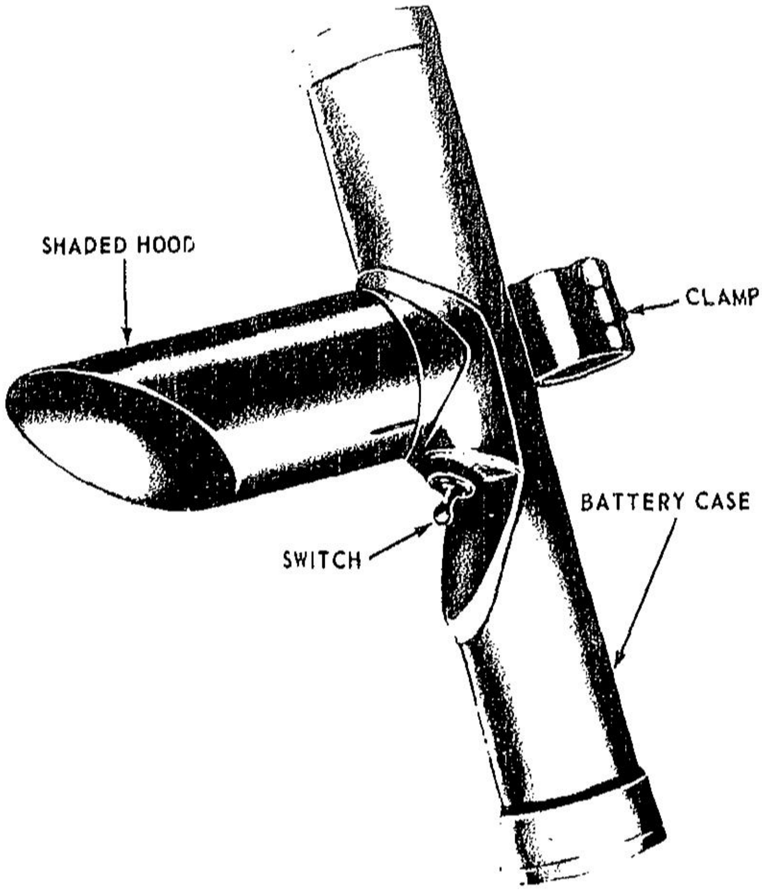


Figure 13. M14 aiming post light.

(3) *The M308A1 muzzle cover, with carrying strap,* is used to protect the mortar bore from foreign matter and moisture. The attached strap is used as a sling when carrying the mortar.

(4) *The M3 shoulder pad,* consists of two pads, one for the left and one for the right shoulder. They are strapped together and provide protection for the shoulders of the squad members.

c. Training Aids. Training aids consist of training projectiles, a chest containing tools for removing spent ignition cartridges, replacing damaged fins on the training projectiles, and recovering the projectiles from the ground. An ammunition instruction chart is also issued.

CHAPTER 3
AMMUNITION AND BALLISTICS

Section I AMMUNITION

44. General

This section covers information on the complete cartridges of semifixed ammunition authorized for use in the 60-mm mortar, M19. It includes a description of the cartridge, means of identification, and care and use.

45. Classification

Based upon use, the principal classifications of ammunition for the 60-mm mortar are—

a. High-explosive (HE), for use against personnel and light materiel targets.

b. Smoke (white phosphorous), for use as a screening, signaling, casualty producing, or incendiary agent.

c. Practice, for training.

d. Training, for training in limited areas.

e. Illuminating, for use in night missions requiring illumination for assistance in observation.

46. Ammunition Lot Number

The ammunition lot number is a code number assigned to each lot of ammunition when it is manufactured. This lot number is stamped or marked on every loaded complete cartridge, on packing containers, and on the accompanying ammunition data card. In making out records, including reports on condition, functioning, and accidents, refer to particular items of ammunition by lot number.

47. Identification

a. Marking on Fiber Containers. Ammunition is readily identified by the markings on the fiber containers in which it is packed. Additional data pertaining to the cartridges are included on the ammunition data card packed with them. The tape on the fiber containers is colored to provide a means of identification as to the type of cartridge.

b. Color of Cartridge. Each cartridge is painted to prevent rust and, by means of the color, to provide a ready means for identification as to type. The colors under the old and newer NATO systems are—

(1) *Old system.*

(*a*) *High-explosive:* olive drab (markings in yellow).

(*b*) *Smoke:* (WP) gray with yellow band (markings in yellow).

(*c*) *Practice:* blue (markings in white).

(*d*) *Illuminating:* gray (markings in white).

(2) *NATO system.*

(*a*) *Chemical.*

1. Persistant gas: gray with two green bands and marking in green.

2. Nonpersistant gas: gray with one green band and marking in green.

3. Smoke (FS) : Light green with marking in black.

4. Smoke (WP or PWP) : Light green with marking in light red.

(*b*) *Illuminating.* White with marking in in black.

(*c*) *Training.* Blue with marking in white.

c. Markings on Cartridge. When removed from its container the cartridge is identified by the following information stenciled on it:

(1) Caliber of mortar in which fired.

(2) Kind of filler.

(3) Model of cartridge.

(4) Ammunition lot number.

48. Care, Handling, and Preservation

a. Ammunition is made and packed to withstand all conditions ordinarily encountered in the field. Nevertheless, since ammunition is adversely affected by moisture and high temperature, give

consideration to its protection from these conditions.

b. Complete cartridges, being fuzed, are handled with care. The explosive elements in primers and fuzes are particularly sensitive to strong shock and high temperature.

c. Do not break the moisture-resistant seal of the fiber container until the ammunition is to be used. When a large number of cartridges (15 or more per squad) are prepared before a combat mission, the cartridges may be removed from the containers, and the propelling increments adjusted. Then reinsert the fin assembly of each into the container to protect the propelling charges.

d. Do not attempt to disassemble any fuze.

e. Protect the ammunition carefully from mud, sand, dirt, and water. See that the cartridges are free of such foreign matter before firing. When ammunition gets wet or dirty, wipe it off at once.

f. Do not allow the ammunition, particularly the powder increments, to be exposed to direct rays of the sun for any length of time. More uniform firing is obtained when the cartridges are at the same temperature.

g. Remove the safety wire from the fuze just before firing.

h. Reinsert the safety wires into all cartridges that have been prepared for firing, but not used. Replace the powder increments that have been removed. Then return the cartridges to their original packing and mark them appropriately. Use these cartridges first in subsequent firing to keep opened stocks at a minimum.

i. Do not handle duds. Duds are cartridges that have been fired but did not explode. They are extremely dangerous because the fuze is armed and any movement of the cartridge may cause it to explode. In training areas, locations of duds are marked by signs and reported to the range officer for destruction.

49. Storage

a. When practicable, store ammunition under cover. When it is necessary to leave the ammunition in the open, raise it at least 6 inches from the ground and cover the pile with a double thickness of tarpaulin. Dig trenches around the pile to prevent water from flowing under it.

b. In arctic weather, leave the ammunition in wooden boxes or crates when placed in storage. Place it on pallets and cover it with a double thickness of tarpaulin.

c. Store white phosphorous cartridges with the fuze end up whenever there is a possibility of the temperature rising above 100° F. (para 52).

50. Authorized Cartridges

Ammunition authorized for use in this mortar is listed in paragraph 45. Because of its stabilizing fins this ammunition even though fired from a smoothbore mortar, is stable in flight and strikes nose end first. The propelling charge, consisting of an ignition cartridge and propelling increments, is attached to the fin assembly shaft or within the fin blades. The ignition cartridge is inserted in the base of the fin shaft. The increments are removable. When fired, the round carries the fired ignition cartridge case with it. The mortar is then ready for the next round. Because the complete cartridge is loaded into the mortar as a unit and provision is made for adjusting the propelling charge, 60-mm mortar ammunition is classified as semifixed.

51. M49A2 High Explosive Cartridge

a. This cartridge is the standard high explosive round provided for the 60-mm mortar. It is used to a much greater extent than any of the other authorized cartridges. It is used chiefly against personnel and is very effective in producing casualties because the fragments of the cartridge fly in all directions at the instant the cartridge hits the ground or any other solid object. It has an effective bursting area approximately 18 meters wide and 9 meters deep.

b. The HE cartridge consists of a hollow steel body (fig. 14), a fin assembly which screws on the rear end of the body and a fuze (M525 or M525A1) which is attached to the front of the cartridge. A TNT bursting charge weighing 0.34 pound is contained in the body of the cartridge and is ignited by the booster charge in the base of the fuze upon impact. The point detonating fuze is described in detail in paragraphs 60 through 62. The fin assembly contains the ignition cartridge. It also provides a means for attaching propelling increments. The fins keep the round stable in flight. By using 4 propelling increments, this cartridge, which weighs 3 pounds (approx), can be fired at the maximum range of 1,790 meters (approx).

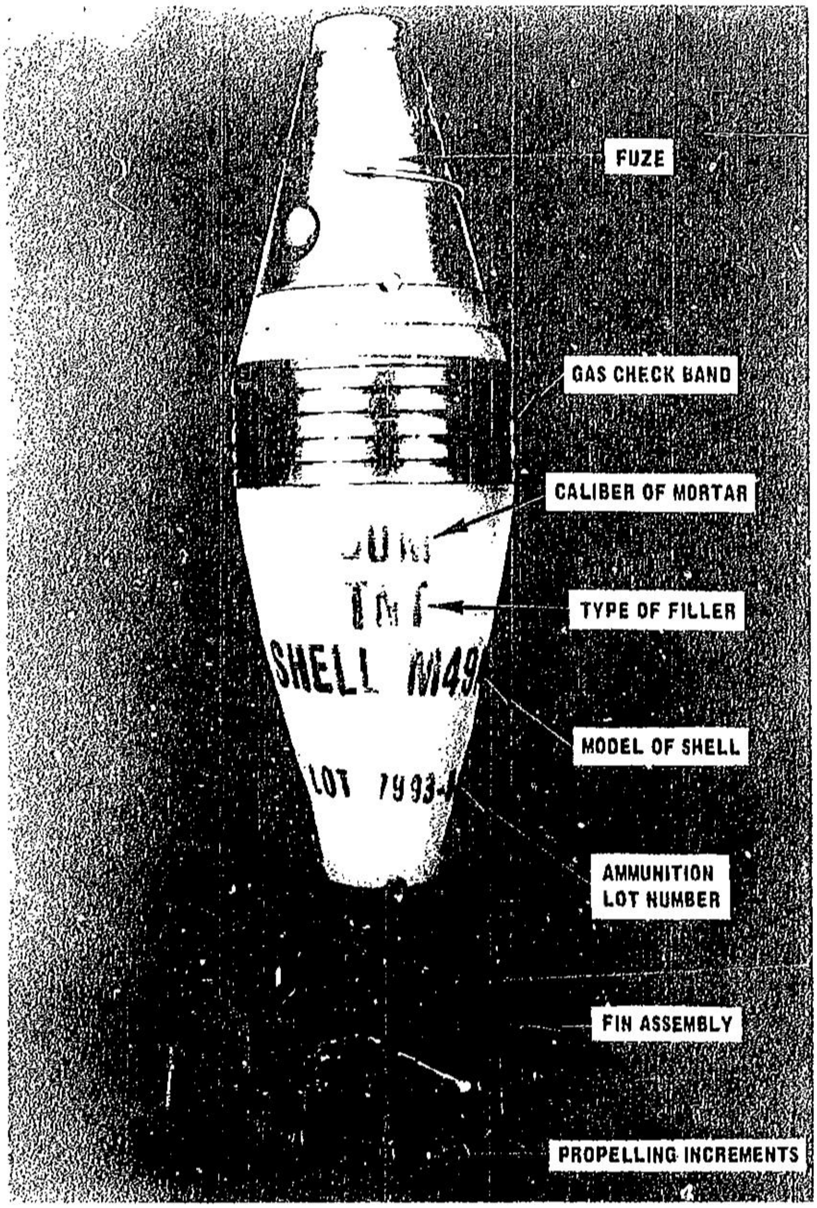


Figure 14. M49A2, HE cartridge, with M525 fuze.

52. M302 Smoke Cartridge

The smoke cartridge, is used as a screening, signaling, casualty-producing or incendiary agent. This cartridge (fig. 15) is similar in design to the HE cartridge. It has a longer body, a thinner body, and a filler of white phosphorous. The bursting charge is designed to burst the cartridge casing and scatter the white phosphorous which ignites when exposed to air. The cartridge has a casualty producing radius of 10 meters and a maximum range of 1,450 meters. It comes equipped with an M82 super-quick fuze. The white phosphorous filler liquefies at temperatures of 100° F. or greater. As the white phosphorous does not entirely fill the space provided for it, a hollow space develops in the upper part of the filler cavity in the cartridge, causing it to be unbalanced and therefore unstable in flight. When stored at temperatures of 100° F. or greater, stack the smoke cartridges with the fuze up so that the hollow space is in the top of the filler cavity and uniform with respect to the axis of the cartridge. Cartridge, 60 millimeter: smoke, WP, M302E1, w/fuze, PD M527B1, will soon be issued to replace the M302 cartridge.

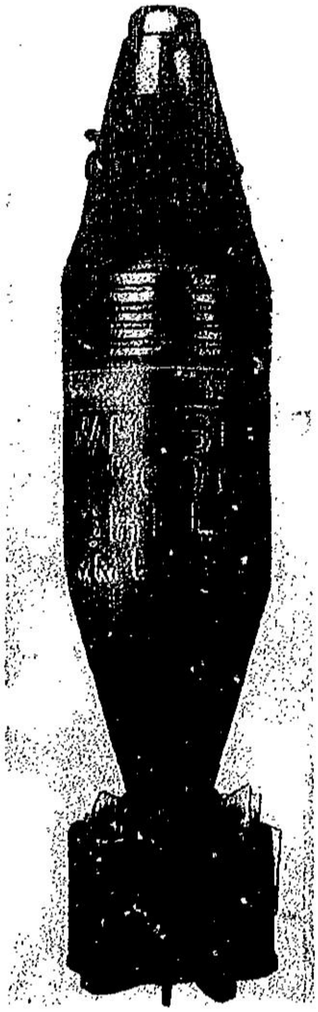


Figure 15. M302E1 smoke cartridge, with M527 fuze.

***Warning:* Short rounds may result when this round is fired at temperatures below 0° F.**

53. M50A2 Practice Cartridge

The practice cartridge differs from the HE cartridge only in color, bursting charge, and casualty effect. It is used in training, and is just as effective as the HE cartridge for this purpose because of identical ballistic qualities. The cartridge has a small, black powder spotting charge as the filler in place of TNT.

54. M83A3, M83A2, or M83A1 Illuminating Cartridge

a. The illuminating cartridge is used in night missions to assist ground troops in observation. It is made up of four major parts: a body tube assembly, an illuminant assembly, a parachute assembly, and a tail assembly. The cartridge is also equipped with four propelling charges.

b. The illuminating cartridge is equipped with the M65A1 or M65 time fuze. The fuze ignites the quick match (after the safety wire is removed and the cartridge is fired), and the quick match then ignites the black powder charge. This black powder charge expels the parachute and illuminant charge assemblies from the cartridge in approximately 14.5 seconds and, at the same time, ignites the illuminant charge. The M83A3 cartridge burns for at least 25 seconds with a minimum of 330,000 candlepower. The M83A1 illuminant charge burns with a minimum of 145,000 candlepower. While in the air, the illuminant charge drops at a rate of 3 meters per second.

c. The illuminating cartridge weighs approximately 4.15 pounds and has a maximum range of 1,000 meters (approx). In common with other pyrotechnics, this cartridge is marked with the type and model of cartridge, mortar from which fired, filler, and lot number.

55. M69 Training Cartridge

The M69 training cartridge (fig. 16) has a solid cast iron body and a standard fin assembly. It weighs 4.4 pounds, and is propelled by an ignition cartridge only. Its maximum range is 225 meters. A firing table for the training shell comes with each container. A hook is also provided with which to recover the shell in the event that it becomes imbedded in soft earth. This shell is valuable as a training aid.

56. Loading Ignition Cartridges

a. The ignition cartridge, M4, is slightly oversize at the base to insure that the cartridge remains in the fin assembly during loading and firing the mortar. The tight fit of the ignition cartridge makes it difficult to fully seat the cartridge in the fin assembly by hand. The cartridges may be easily and safely loaded with the loading device (fig. 17). The cartridge chamber in the fin assembly must be thoroughly cleaned before reloading.

b. Care must be taken while seating the cartridge fully in the fin assembly to avoid tapping or striking the primer. If the primer is pressed against a surface or if it is tapped, or struck, it may detonate the cartridge and cause serious injury.

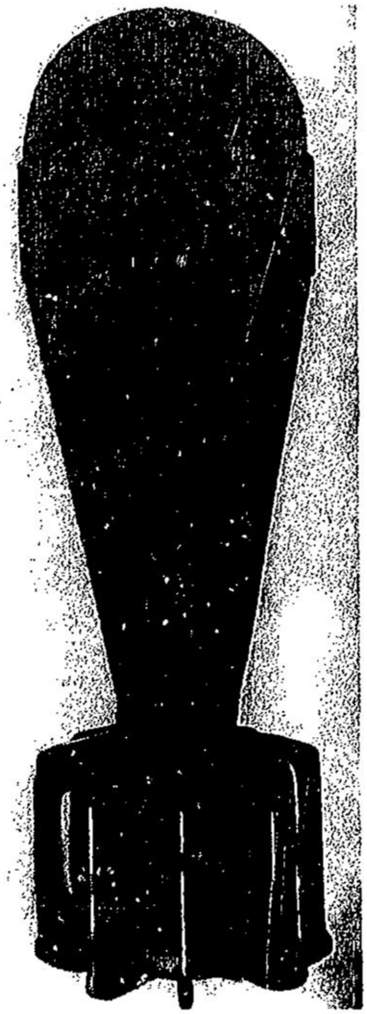


Figure 16. M69 training cartridge.

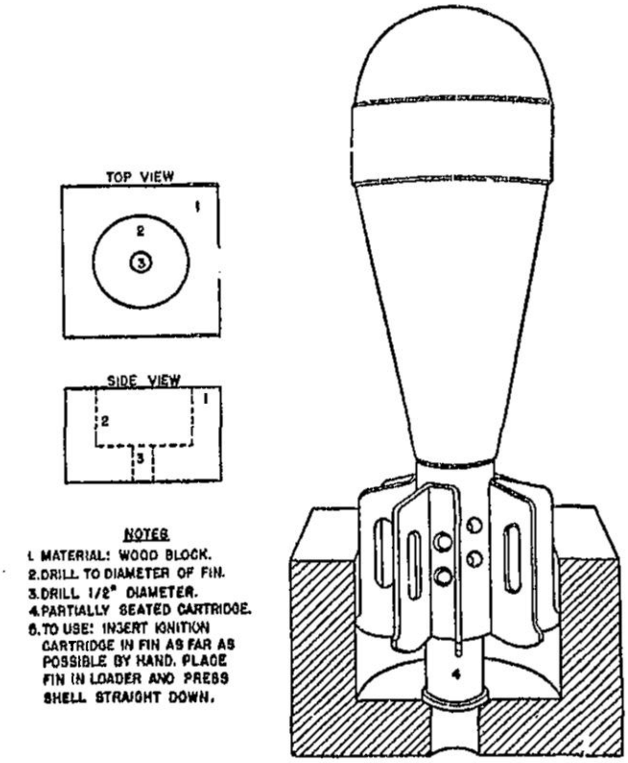


Figure 17. Loading device for training cartridge.

57. Removing Expended Ignition Cartridges

a. The following modification of the fin of the training cartridge is helpful in removing expended ignition cartridges: Bore a hole 3/8-inch in diameter completely through the outer thread of the fin assembly, parallel with the longer axis of the fin assembly. This permits the insertion of a large nail or spike through the length of the fin assembly to force out the expended ignition cartridge.

b. To remove an expended ignition cartridge, unscrew the fin assembly from the base end of the round. Then place the fin assembly on a block of wood, 4 inches by 8 inches by 2 inches, with the base end of the fin assembly over a hole 1 inch in diameter bored through the centers of the block of wood. Place a nail or spike through the open (bored) end of the outer thread of the fin assembly. Drive this nail through the fin assembly forcing the ignition cartridge from its seat. Then remove the ignition cartridge from the fin assembly with the extractor.

c. Before replacing the fin assembly in the round, see that the shoulder and outer threads of the fin assembly, and the shoulder and inner threads of the cartridge, are free from any foreign material. If there are any particles left on the shoulders and threads, the fin assembly will not seat properly in the base end of the round. This causes a rupture in the base of the cartridge when fired. When this rupture occurs, the cartridge cannot be used.

58. Preparation for Firing

Ammunition is issued as semifixed complete cartridges. Prepare it for firing by adjusting the propelling charge for the zone to be fired and by removing the safety wire from the fuze.

59. Propelling Charges

Propelling charges for mortar ammunition consist of square powder increments and an ignition charge. The full charge consists of an ignition cartridge and four equal propellent increments (bun-

dles of sheet powder) assembled to the base of the cartridge as issued. The increments are attached to the fin assembly by increment holders. To prepare the charge for firing, it is only necessary to remove those increments not required. Short rounds result when increments are wet. Although a waterproof cellophane bag covers the increments, they should be protected from rain and moisture as much as possible.

Note. Destroy unused increments after firing by burning them. Do not allow excess increments to accumulate near the mortar positions. Move them at least 50 meters from mortar positions, parked vehicles, and ammunition piles. Clear off grass or brush for at least 10 meters from the burning area to prevent starting range fires. *Do not burn the increments in piles.* Spread them in a train of the following depth and width: 2 inches to 3 inches deep, 6 inches wide and as long as necessary. Ignite the powder train by lighting a starting train consisting of not less than 1 foot of inert material (dry grass, leaves, newspapers). *Prohibit smoking or building fires around ammunition or piles of excess increments* except when actually destroying them as described above.

60. M525A1 or M525 Fuze

These fuzes are the super-quick (S.Q.) type, and they are identified by PDF (point detonating fuze) M525A1 or M525 stamped on the body. These fuzes are designed to function before any penetration occurs, permitting the maximum surface effect of fragmentation of the cartridge. For use in the field, it is issued assembled to the cartridge as a part of the complete cartridge. To prepare for firing it is only necessary to remove the safety wires.

61. Safety Features of M525A1 or M525 Fuzes

a. These fuzes are classified as bore-safe. They are equipped with safety devices that keep the bursting charge from exploding while the cartridge is in the barrel—even should the primer or detonator malfunction.

b. A safety wire passes through the body of the fuze and the setback pin, thereby locking all movable parts in their original safe position. Pull the safety wire just before firing. If a cartridge is fired without pulling the safety wire, it may or may not explode upon impact. The safety wire is designed to lock the setback pin in place only during normal handling of the cartridge before firing.

62. Functioning of the M525A1 and M525 Fuzes

Upon firing (after removal of the pull wire and safety wire) setback causes the setback pin to release the boreriding pin, which moves outward to contact the bore of the mortar and is ejected as the cartridge leaves the mortar. Setback also frees the pallet and escape pinion wheel which begins to rotate a center gear of the dislodged arming mechanism. This causes the firing pin to act as a detent to prevent the slider from moving the detonator into line with the firing pin. This causes a 3 second arming delay. Upon impact, the striker is driven against the firing pin spring, which forces the firing pin into the detonator, which detonates in turn the tetryl lead charge, tetryl booster, and main bursting charge of the cartridge. A detailed discussion of the functioning of these fuzes is contained in TM 9-1300-205.

63. M65 and M65A1 Time Fuzes

Functioning of these fuzes is discussed in detail in TM 9-1300-205.

64. M527 Fuze Series

These fuzes are identical with the M52 except that they contain a smaller booster charge and an intrusion. They are used on the smoke cartridge only. The M527 and the M527A1 have a plastic body, and the M527B1 and the M527A1B1 have an aluminum body.

65. Firing Tables

a. To convert ranges in yards or meters into elevations in degrees or mils and number of propellent increments (referred to as charges), use the firing tables that are packed with each bundle of ammunition. These tables include a deflection-conversion table. Firing tables for instructional use may be obtained on requisition.

b. Tables applicable to the various types of 60-mm cartridges are as follows:

(1) *FT 60-L-2 (abridged).*—For firing: HE cartridge, M49A2 W/PD Fuze, M52 Practice cartridge, M50A2, W/PD Fuze, M52 Smoke cartridge, WP, M302, W/PD Fuze, M82.

(2) *FT 60-C-2 (abridged).*—For firing: Training cartridge, M69.

c. For example of current firing tables, see FT 60-L-2.

d. Uses.

(1) As mortar fire is usually adjusted fire (para 157), select a charge zone for the initial range that permits a subsequent increase or decrease in range without changing the charge. Where two elevations and two charges are available for selection, select the charge that will give the greatest latitude without changing the charge. For example, using the HE cartridge for an initial range of 650 meters, use 72°, charge 2. When there is a choice between two charge zones, equal latitudes in firing being provided in both, select the lower charge because less dispersion results with the lower charge.

(2) It is undesirable during adjustment of fire to change to a different charge zone. Fire adjustment is less accurate where there is a shift between charge zones during adjustment.

(3) In firing on targets involving searching fires select the elevation in degrees that will permit the use of the same charge throughout. For example, using the HE cartridge for zone 800 to 900 meters, use charge 2 with the corresponding elevations.

(4) In firing on targets involving close fire, select the elevation in degrees that will permit the use of the lowest charge. For example, using the HE cartridge for an initial range of 650 meters, use 56°, charge 1.

Section II. BALLISTICS

66. General

An understanding of ballistics or the forces that act on a projectile enables a mortar crew to minimize the adverse forces and obtain more effective fire on a target. Many conditions affect mortar fire and the probability of obtaining identical trajectories is remote. That is, if a number of cartridges are fired from a mortar laid each time at the same elevation and deflection, all of these cartridges do not fall on the same point. Some of the conditions affecting the motion of the round that can be controlled partially by the mortar crew are—muzzle velocity, elevation and direction, forces acting on round during flight, and dispersion. For a detailed discussion on these items, see FM 23–92.

67. Ground Burst

Of primary interest to the observer is the fact that more of the fragments of the burst of the 60-mm cartridge fall to the rear of the point of impact than to the front (fig. 18). A cartridge falling just over the target, therefore, is more effective than a cartridge falling just short of the target.

68. Appearance of Bursts

An observer familiarizes himself with the appearance of the bursts of different types of cartridges (fig. 19) so that he can identify the bursts of the type requested in an area where different types of fire are being delivered.

a. HE Cartridge, Super-Quick Fuze. The black smoke is discolored by dirt and spreads both upward and laterally.

b. WP Smoke Cartridge. Flying particles of burning white phosphorus are first observed. White phosphorus burns rapidly and at once forms a cloud of white smoke which tends to rise because of the heat generated by the burning phosphorus.

Section III. DESTRUCTION OF ORDNANCE MATERIEL IN EVENT OF IMMINENT CAPTURE

69. General Principles

Tactical situations may arise when, owing to limitations of time or transportation, it becomes impossible to evacuate all equipment. To prevent its capture intact and its subsequent use by the enemy, in such situations, destroy all materiel that cannot be evacuated. When thorough destruction of all parts cannot be completed, destroy those parts essential for using the mortar. Ruin or remove the other parts that cannot be duplicated easily by the enemy. Destroy the same essential parts on all like units to prevent the enemy from constructing one complete unit from the several damaged ones by consolidating the serviceable parts. All units should be trained to destroy the

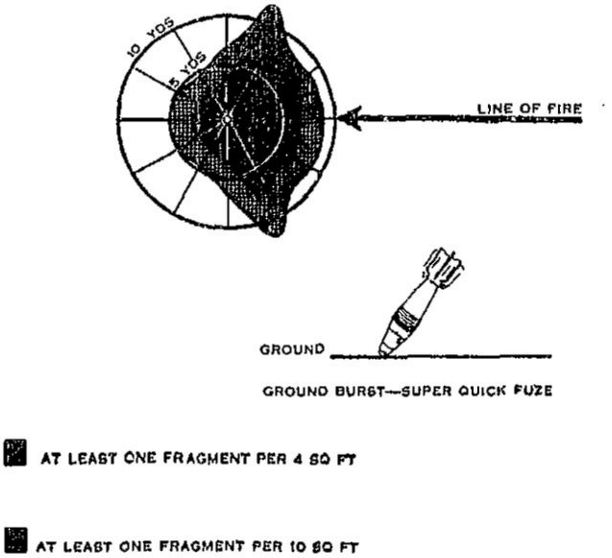


Figure 18. Fragmentation pattern of a 60-mm mortar cartridge.

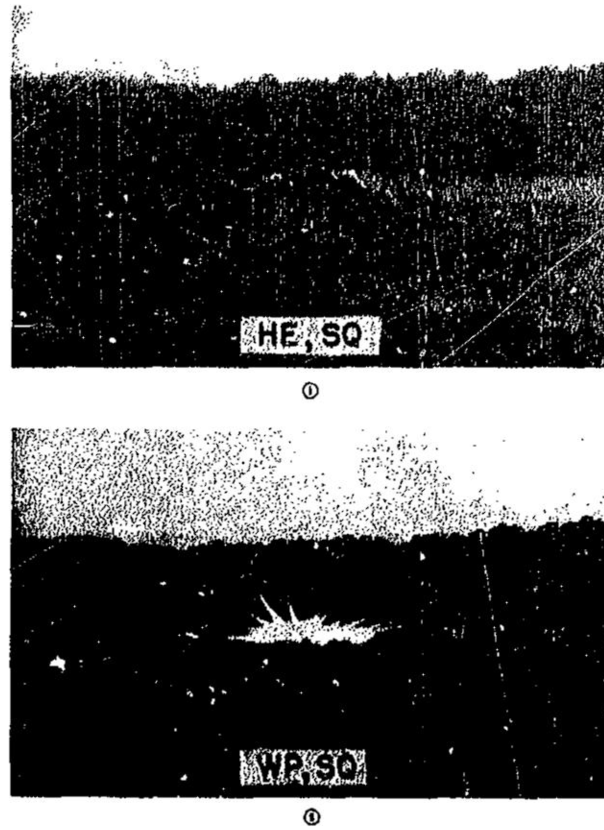


Figure 19. Appearance of bursts.

materiel issued to them. *This training does not involve the actual destruction of materiel.*

70. Methods of Destroying the Barrel

Destroy the barrel by the first method when possible. When the first method cannot be used, use the second or third method in that order. The destruction will then be uniform whether or not the method is carried to completion.

a. Method No. 1. Place a complete cartridge, with 20 propellant increments attached and with the safety wire in the fuze still in place, part way into the mortar barrel. Block the cartridge in this position by jamming a stick, small-arms cartridge, or loop of one-fourth inch or larger cord between the cartridge and the side of the mortar barrel. Attach a cord 30 meters long to the stick, cartridge, or loop. Take a covered position (fig. 20) at least 30 meters away and pull the cord to release the cartridge so that it slides down the barrel. The excess pressure caused by the large number of increments will burst the base end of the barrel. Elapsed time by this method—1 minute. Or, set the selector for lever fire and drop a complete cartridge with 20 additional charges on it into the tube. Attach a 30-meter cord to the firing lever so it will activate the firing lever. Take cover at least 30 meters away and pull the cord. The excess pressure will burst the base end of the barrel.

b. Method No. 2. Dismount the mortar and build up the area in the vicinity of the yoke with dirt so it will support an incendiary grenade. Build up the area around the firing mechanism housing in a similar manner. Place one M14 incendiary grenade on the yoke and another incendiary grenade on top of the firing mechanism housing. Make sure that the dirt mounds hold the grenades in place. Pull the pin on each grenade and leave the immediate area. This method will destroy part of the bipod and the barrel, and part of the firing mechanism housing and baseplate.

c. Method No. 3. Make the barrel useless by puncturing with 7.62-mm bullets fired from a minimum distance of 25 meters.

71. Destruction of Ammunition

Usually there is not enough time to permit the deliberate destruction of all the ammunition in the forward combat areas. When time does not permit, consume ammunition on hand by firing the cartridges rapidly in the direction of the enemy. When enough time and materials are available, destroy large amounts of ammunition by the methods outlined in paragraphs 72 and 73. These methods require from 30 to 60 minutes. For methods and safety precautions, see FM 5-25.

Figure 20. Demolition of mortar using excess increments.

72. Destruction of Unpacked Ammunition

Follow the procedure in *a* and *b* below:

a. Stack ammunition in small piles. Stack or pile most of the available gasoline in cans and drums around the ammunition. Throw onto the pile all available inflammable materials such as rags, scrap wood, and brush. Pour the remaining gasoline over the pile. Use enough inflammable material to insure a very hot fire. Ignite the gasoline and *take cover.*

b. Mortar rounds can be destroyed by sympathetic detonation, using TNT. Stack the ammunition in two stacks, about 3 inches apart, with the fuzes in each stack toward each other. Place TNT charges between the stacks, using a minimum of 1 pound of TNT for every 10 rounds of ammunition. Detonate all TNT charges simultaneously from *cover.*

73. Destruction of Packed Ammunition

Follow the procedure in *a* through *c* below:

a. Stack the bundled ammunition in small piles. Cover with all available inflammable materials, such as rags, scrap wood, brush, and gasoline in drums or cans. Pour gasoline over the pile. Ignite the gasoline and *take cover.* (Before burning small-arms ammunition, break it out of the boxes or cartons.)

b. The destruction of packed ammunition by sympathetic detonation with TNT is not advocated for use in forward combat zones. Satisfactory destruction involves putting the TNT in alternate bundles of ammunition, which is a time-consuming job.

c. In rear areas or fixed installations, sympathetic detonation may be used to destroy large ammunition supplies when destruction by burning is not feasible. Stack the bundles. In each row place sufficient TNT blocks to have 1 pound of TNT for every 10 cartridges of 60-mm ammunition. Place the TNT blocks at the fuze end of the cartridges. Detonate all TNT charges simultaneously. For details of demolition planning and procedure, see FM 5-25.

74. Destruction of Fire-Control Equipment

Fire-control equipment, including sights and binoculars, is difficult to replace. Destroy fire-control equipment last. When evacuation is not possible, burn inflammable items like firing tables and improvised mil scales and alidades, and smash all optical equipment like sights, binoculars, and compasses.

75. Destruction of Captured Enemy Materiel

Destroy captured enemy materiel that is not suitable for repair and issue to troops in the same way as the equivalent United States equipment. Destroy it before destroying United States equipment.

CHAPTER 4

GUNNER DRILL

76. Introduction

This chapter covers the training and exercises for the gunner. In this phase of training all members of the mortar crew are trained in the duties of each member.

77. General

This section covers the instruction and training for the gunner. The M4 sight is used in the description, but the techniques used are the same with the M34 and M53 sights, except for the techniques concerned with setting data on the sight. All squad members should receive the progressive sequence of training. The unit to be trained is organized into small groups or squads, and an assistant instructor is assigned to each group to supervise its training. The assistant instructors demonstrate each operation as it is being explained. Then each group or squad is given practical work in the exercise just explained and demonstrated. Mounting the mortar is covered in paragraph 13.

78. Checking Seat of Sight and Correct Removal Procedure

a. The gunner automatically checks the seating of the sight in the slot every time he places it on the mortar. His failure to do this may cause a serious waste of time and ammunition during fire for adjustment, because true angles of elevation, corresponding to the elevations set on the sight, can only be laid on the mortar when the sight is latched securely. The following procedure is used in checking to see that the sight is properly seated (fig. 21)—the gunner mounts the sight on the mortar and then places his left index finger against the sight slot and underneath the body of the sight; with his left thumb extending over the cross-level and the remaining fingers of his left hand grasping the under portion of the sight body, he attempts to lift the sight out of the slot; when the sight has been properly inserted, the hook on the latch continues to engage the notch in the sight slot.

b. To prevent damage to the sight by recoil of the mortar before the baseplate is thoroughly seated, the sight is removed before firing the first three cartridges. The gunner removes the sight carefully to avoid disturbing the laying of the mortar.

c. To remove the sight, follow this procedure (fig. 22)—from a standing position, the gunner places the fingers of his left hand on the sight in the same manner as for checking the seating of the sight; with his right thumb, he exerts pressure on the knurled portion of the latch and places the remaining fingers of his right hand on top of the yoke; the upward pressure of his left hand is counteracted by the pressure exerted on the yoke with the fingers of his right hand. This method causes the least disturbance in the laying of the mortar.

79. Laying for Elevation

After the gunner sets the sight, he lays the mortar. Laying the mortar is putting the proper angle

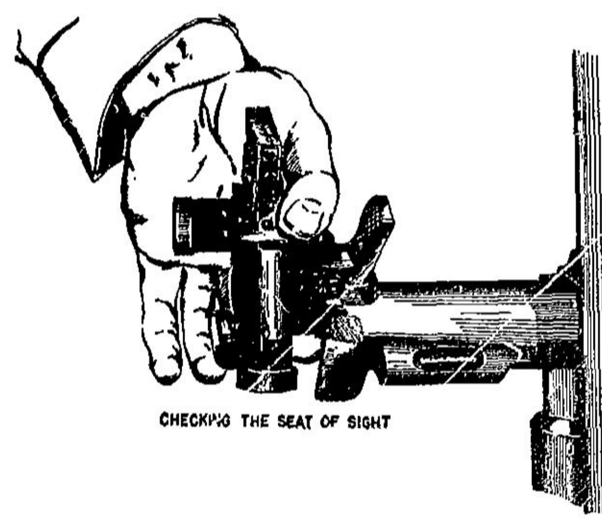


Figure 21. Checking the seat.

of elevation on the barrel and sighting the mortar in the proper direction. The sight is only an angle measuring instrument on which deflection and elevation settings are made without affecting the axis of the bore. To lay the mortar for elevation, the gunner obtains the elevation from the firing table and sets it on the sight. He then elevates or depresses the barrel by turning the elevating crank until the bubble in the longitude level is centered.

80. Laying for Direction

a. Only those techniques that pertain to using the M4 sight are discussed in this section. For a detailed explanation on using the M34A2 and M53 sights, see FM 23–90 or FM 23–92.

b. Accurate firing is possible only when the vertical line of the collimator is laid on exactly the same position of the aiming point for each cartridge fired at the same target, with the mortar accurately cross-leveled. When an aiming post is used, the gunner lays the mortar so that the vertical line of the collimator is made to coincide with the left edge of the post (fig. 23). When an aiming point other than a stake is used, the gunner selects a clearly defined point or vertical edge on which to lay. In aiming, he holds his eye 3 to 10 inches from the lens of the collimator and in such a position that both the aiming point and the vertical line of the collimator are visible. He disregards the open sight unless the collimator is broken.

c. When the gunner sets the sight for deflection, the verticle line of the collimator moves off to one side of the aiming post (1 and 2, fig. 24). To place

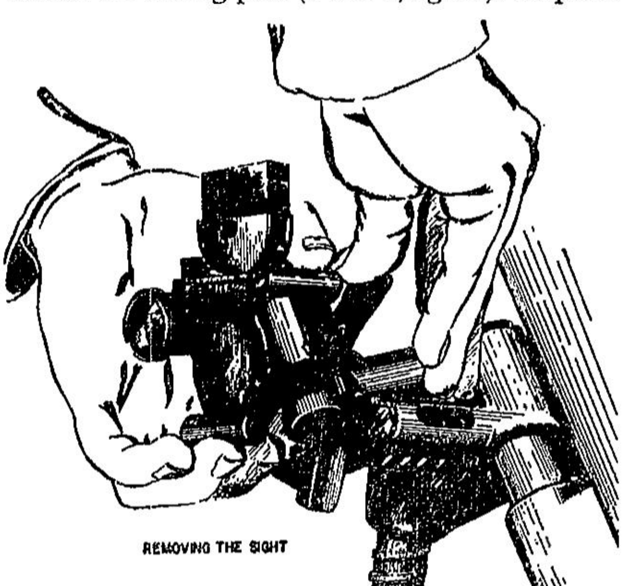


Figure 22. Removal of the sight.

the vertical line of the collimator back on the left edge of the aiming post he traverses the mortar (right or left) with the traversing handwheel, cross-leveling simultaneously with the adjusting nut. A deflection set on the deflection scale of the sight (for example, a left deflection) moves the vertical line of the collimator in the opposite direction (right) and requires him to manipulate the traversing handwheel (to the left) to bring the vertical line back on the left edge of the aiming post. The two movements of traversing and cross-leveling are combined in a simultaneous operation. In traversing and cross-leveling, the gunner operates the traversing handwheel with his right hand and, at the same time, operates the adjusting nut with his left hand. He turns both hands in the same relative direction to keep the cross-level bubble centered during traverse. To keep the mortar cross-leveled, one turn of the adjusting nut is taken to approximately nine turns of the travers ing handwheel. (This ratio varies slightly with different mortars.)

d. Before the gunner begins to traverse back to the aiming stake, he checks the cross-level bubble to see that it is centered. If it is not, he centers it with the adjusting nut. During the traverse back to the aiming stake, he watches the cross-level bubble to keep it centered. He looks at the collimator from time-to-time to determine how much more traverse is needed. However, while traversing the mortar, he does not watch the collimator.

e. Whenever it is impossible to place the deflection on the mortar by the traversing handwheel (the limit of traverse is reached before the sight is on the aiming post), the mortar is laid for deflection by moving the bipod legs. This is necessary because there are only 350 mils of traverse possible on the traversing mechanism; however, a deflection of 150 mils on either side of zero (a total of 300 mils) can be set on the M4 sight; and the deflection capacity is 6400 mils on the M34 and M53 sights. In these cases the gunner sets the sight for the announced deflection, centers the traversing bearing, and moves the bipod legs until the vertical line of the sight is alined approximately on the left edge of the aiming post. The gunner then makes the final small shift to the stake with the traversing handwheel and the adjusting nut. Whenever a new aiming post is indi-

cated in the fire command, the gunner lays the mortar by moving the bipod legs.

81. Cross-Leveling

Cross-leveling is that operation by which you keep the traversing mechanism horizontal. Cross-level by turning the adjusting nut until the bubble in the cross-level assembly is centered. Follow the procedure as for centering the elevation level bubble; however, the cross-level bubble is even more sensitive to adjusting nut movements than the elevation bubble is to the elevating crank. Do not attempt to center the cross-level bubble by turning the traversing handwheel.

82. Laying for Direction by Azimuth

a. As the mortar is normally located in defilade, it is laid by compass azimuth when the direct alinement method cannot be used (para 80).

b. The procedure for laying the mortar on a given azimuth is as shown in (1) and (2) below:

(1) The squad leader indicates the position for the mortar, and the gunner drives a stake in the ground to mark the position of the baseplate. Making sure that the mortar and other metallic equipment are at a distance of not less than 10 meters from the position, the gunner rests his compass on the stake and rotates it until the azimuth announced by the squad leader is laid off on the mil scale. Sighting through the compass, he then directs the assistant gunner to drive an aiming post on this azimuth at a distance of about 25 meters.

(2) The mortar is mounted at the position of the compass stake as described in paragraph 13. With the initial setting placed on the sight, the gunner shifts the bipod until the vertical line of the collimator is approximately on the left edge of the aiming post. He lays for elevation, cross-levels, and then lays for direction.

83. Procedure for Laying Mortar

a. With the mortar mounted, you receive the following fire command: for example, NUMBER ONE, HE QUICK, LEFT FOUR ZERO, BASE STAKE, ONE ROUND, CHARGE ONE, SIX FIVE AND ONE-QUARTER. Repeat the command.

b. Immediately set the deflection left 40 on the deflection scale with your left hand and set 65¼° on the elevation scale. At this point, level both bubbles. Since the angles of deflection and elevation have been measured on the sight, you next turn the elevating crank and traversing handwheel in the proper direction to lay the mortar. Center the elevation level bubble and rotate the adjusting nut until the cross-level assembly bubble is centered. Check the vertical line of the sight and simultaneously turn the adjusting nut and traversing handwheel in the same direction until the vertical line is laid on the left edge of the aiming post. Again check the elevation level bubble to insure that it is still centered. Then command FIRE.

84. Procedure for Laying for Large Deflection Shifts

a. Whenever it is impossible to place the deflection by the traversing handwheel (the limit of traverse is reached and the sight is still not laid on the aiming post), lay for direction by moving the bipod legs. (There are only 95 mils of traverse possible on either side of the center of the traversing mechanism (a total of 190 mils), while a deflection of 150 mils on either side of zero (a total of 300 mils) can be set on the sight.)

b. With the sight set for deflection and elevation, center the traversing bearing on the traversing nut with the traversing handwheel.

c. Direct No. 2 to move the bipod until the vertical line of the sight is alined approximately on the left edge of the near aiming post. (If two posts can be seen, use the far aiming post.)

d. Center the elevation bubble with the elevating crank.

e. Cross-level with the adjusting nut.

f. Make the final small adjustment for deflection with the traversing handwheel and the adjusting nut to obtain the proper compensated sight picture.

g. Check again to insure that the elevation bubble is still centered, and command FIRE.

h. Whenever a new aiming post is indicated in the fire command, lay the mortar by moving the bipod as indicated above.

85. Manipulation for Traversing Fire

a. To distribute fire laterally across a target in width, use traversing fire. Fire is adjusted on the target. Lay the mortar with the firing data (de-

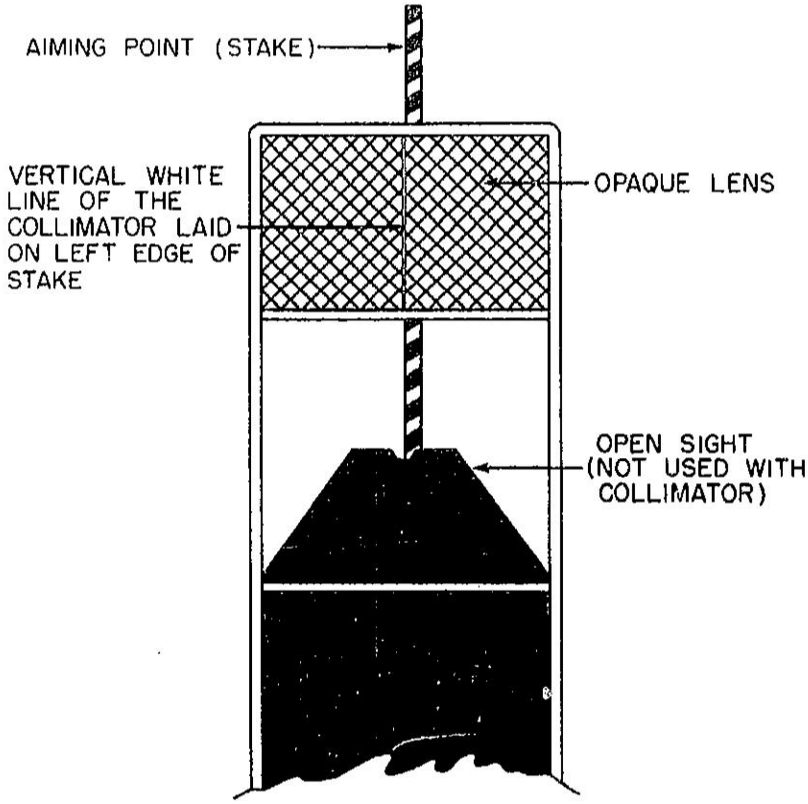


Figure 23. Correct sight picture.

flection and elevation) for the last cartridge fired in the adjustment or the data to fire the first cartridge on its portion of the target. You receive a subsequent fire command as follows:

FOUR ROUNDS
TRAVERSE RIGHT THREE TURNS
CHARGE TWO
SIX THREE AND ONE-HALF

b. Repeat each element of the command. As no deflection is included in this fire command, you do not place any new deflection on the deflection scale of the sight. Then set the elevation scale at 63½° and repeat CHARGE TWO (para 86*c*).

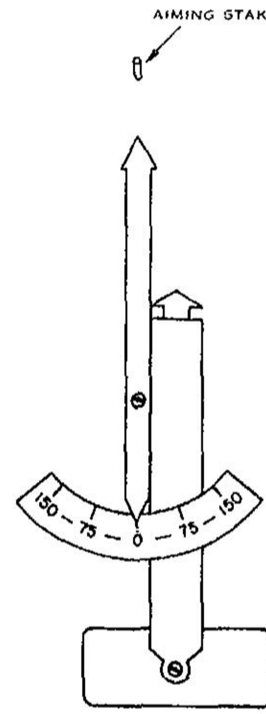
86. Manipulation for Searching Fire

a. To distribute fire over a target in depth, use searching fire. Fire is adjusted on the target. Lay the mortar with the firing data for the last cartridge fired in the adjustment or the data to fire the first cartridge on its portion of the target. You receive a subsequent fire command as follows:

RIGHT SIX ZERO, BASE POST (AIMING POST)
FOUR ROUNDS
SEARCH DOWN TWO TURNS
CHARGE TWO
SEVEN ONE AND ONE-HALF

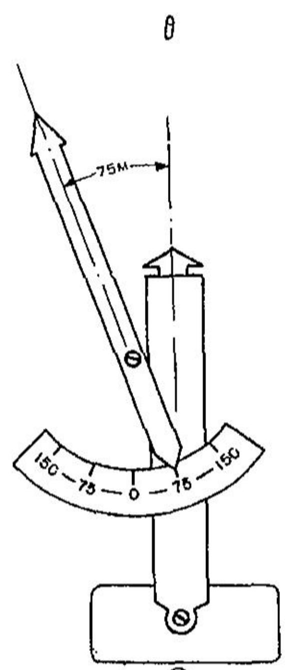
b. Repeat the fire command. Then set a deflection of right 60 on the deflection scale of the sight and an elevation of 71½° on the elevation scale and repeat CHARGE TWO.

c. Then check the traversing mechanism to see whether or not there is enough space on the traversing tube to allow you to traverse right a total of six turns (the number of turns announced in the fire command times the number of intervals between cartridges). If there is not, prepare the mortar to traverse right by turning the traversing handwheel until the traversing bearing is positioned all the way to the right side of the yoke (barrel to the left). Then turn the traversing handwheel back one and one-half or two turns to allow for some latitude for the final adjustment on the aiming posts. Direct the assistant gunner to move the bipod legs until the vertical line of the sight is laid on the left edge of the aiming posts. Then center the bubble in the eleva-



①

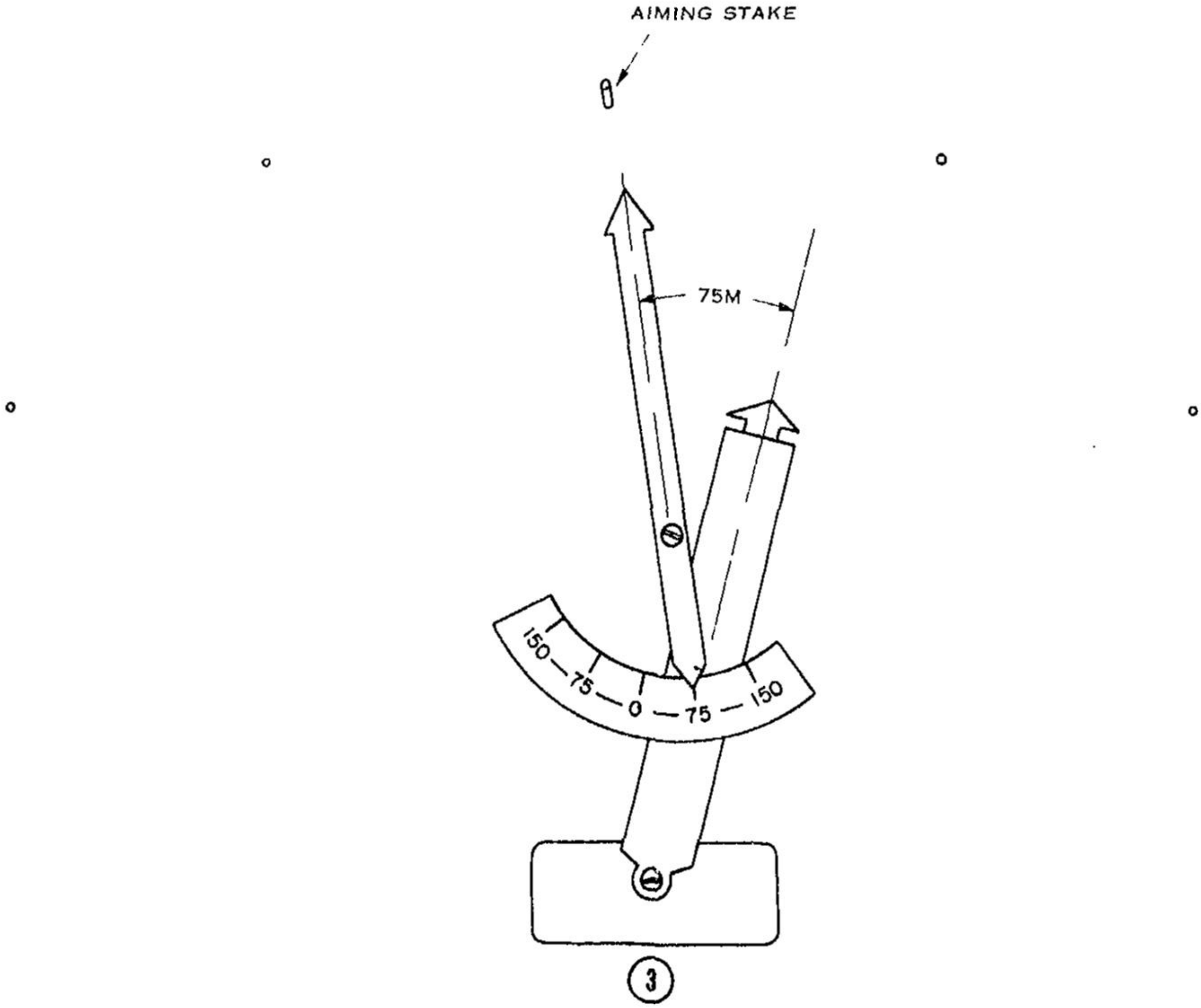
DEFLECTION SCALE OF SIGHT SET AT 0 AND THE VERTICAL WHITE LINE OF THE COLLIMATOR LAID ON THE LEFT EDGE OF THE AIMING STAKE



②

SETTING A RIGHT 75 ON THE DEFLECTION SCALE OF THE SIGHT

Figure 24. Laying for direction.



MORTAR HAS BEEN TRAVERSED (AND CROSS-LEVELED) TO THE RIGHT SO THAT THE VERTICAL LINE OF THE COLLIMATOR IS LAID BACK ON THE LEFT EDGE OF THE AIMING STAKE. THE MORTAR BARREL IS NOW POINTING 75 MILS TO THE RIGHT OF THE AIMING STAKE (AN ANGLE OF 75 MILS HAS BEEN MEASURED TO THE RIGHT)

Figure 24—Continued.

tion level, cross-level, and lay accurately for deflection with the traversing handwheel while keeping the mortar cross-leveled with the adjusting nut. Check the elevation bubble to insure that it is still centered. When you are satisfied with the lay of the mortar, command FIRE ONE.

87. Referring Sight

a. Referring the sight is making a deflection change on the sight *without disturbing the lay of the mortar.* To refer the sight, turn the deflection knob until a given deflection is set on the sight scale. Referring the sight is done to establish an aiming line on which to place an aiming post.

b. Referring the sight is necessary when adjusting a parallel sheaf (para 189 and 190) for the section which is being controlled by an FDC. The procedure is as follows:

(1) To adjust a parallel sheaf of the section, the FDC gives the fire command, for example:

RIGHT SEVEN FIVE, BASE POST
SECTION RIGHT
ONE ROUND
SEVEN ONE AND ONE-HALF

The burst of the round from the No. 1 mortar hits the ground 25 mils to the right of its proper place in the sheaf. The No. 1 mortar is given the command:

NUMBER ONE, DO NOT FIRE,
RIGHT FIVE ZERO, BASE STAKE
SEVEN ONE AND ONE-HALF

to move its burst into its proper place in the sheaf.

(2) Lay the mortar with this new deflection. The deflection on the No. 1 mortar is now different from the other mortars in the section. To make the deflection of the No. 1 mortar coincide with the other mortars, the FDC gives the command:

NUMBER ONE, DO NOT FIRE, RIGHT SEVEN
FIVE, ELEVATION SEVEN ONE AND ONE-HALF,
REFER, REALINE, BASE
POST (AIMING POSTS)

(3) Refer the sight to right 75 mils and direct No. 3 in realining the base post on the new line of sight through the collimator (fig. 25).

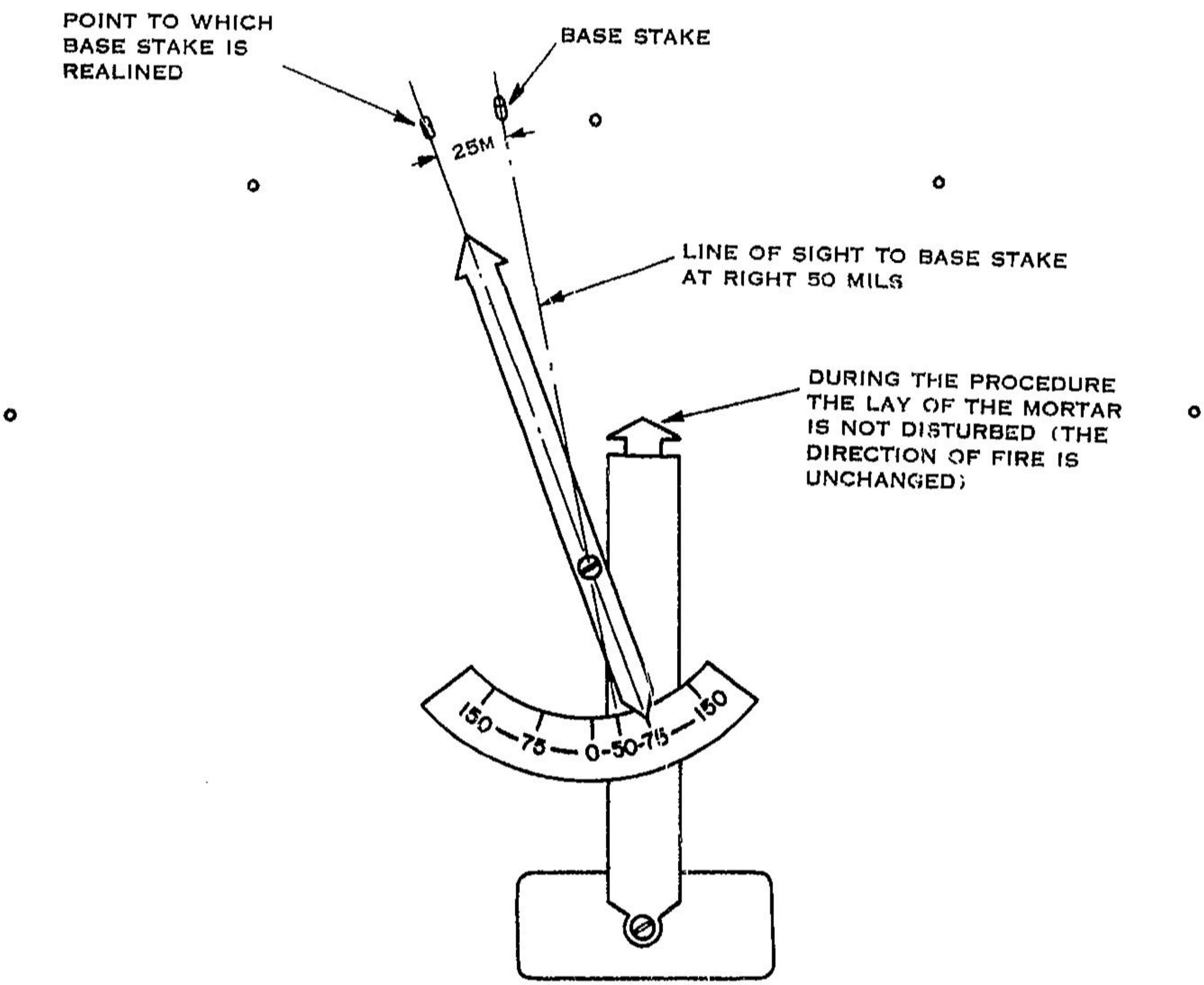


Figure 25. Referring the sight.

c. The cartridge from the No. 1 mortar hits 25 mils to the right of its proper position in the sheaf when that mortar was laid with the same deflection as the other mortars. By laying the mortar at right 50 mils, the barrel was moved 25 mils to the left. If a cartridge were fired from the No. 1 mortar with this deflection, it should burst in its proper place in the sheaf. However, for firing on any other target by the section, this 25-mil error of No. 1 mortar would still be present unless a different deflection were given to No. 1 mortar. To prevent the necessity for giving one deflection to Nos. 2 and 3 and another to No. 1 mortar, the base post of the No. 1 mortar was moved 25 mils to the left of its original position. This was accomplished by referring the sight of the No. 1 mortar to right 75 mils and realining its base post on the new line of sight through the collimator. For all subsequent targets on which a parallel sheaf is to be fired, the No. 1 mortar is given the same deflection as the other mortars in the section. In other words, its cartridges will fall in their proper place in the sheaf because the barrel will be pointed 25 mils farther to the left as its base post has been moved 25 mils to the left.

88. Placing Additional Aiming Posts

a. General. Since the maximum deflection which can be set on the sight is 150 mils to the right or left of zero, it becomes necessary to set out additional aiming posts. These are set at 150-mil intervals to the right and left of the base post and make possible the laying of the mortar on targets located at more than 150 mils to the right and left of the registration point. These posts are placed after initial direction is established or after adjustment on the registration point has been completed and the sheaf adjusted parallel on the command PLACE OUT TWO (FOUR, etc.) ADDITIONAL AIMING POSTS.

(1) The number of posts to be set out depends on the width of the section's sector of responsibility and is determined by the FDC. Normally, it does not exceed 1,500 mils. In the attack, at least two additional posts are placed out. In the defense, at least four additional posts are placed out. Whenever the situation permits, place the posts at least 25 meters from the mortar.

(2) When the squad or section is not controlled by an FDC, additional aiming posts are placed after initial direction is established or after marking base deflection.

b. Placing the Posts (fig. 26).

(1) *For two posts.* With the deflection scale on the sight set at zero and the vertical line of the collimator laid on the left edge of the baseplate, place out two additional aiming posts as follows: Without moving the mortar, set the deflection scale at right 150 mils and direct No. 3 to drive the *left posts* so that the left edge of the post is in alinement with the vertical line of the collimator. This post is then 150 mils to the left of the base post. Then rotate the deflection knob until the scale registers left 150 mils, and have No. 3 drive the *right post.* These posts make it possible to engage targets 300 mils to the right and left of the base post because, with the deflection scale set at zero, a movement of the bipod to place the vertical line of the collimator on the right (or left) post permits the mortar to be shifted an additional 150 mils to the right (or left). Therefore, with two additional posts, a frontage of 600 mils can be covered.

Example: To engage a new target which is 220 mils to the left of the registration point, the fire command for direction is LEFT SEVEN ZERO, FIRST LEFT POST.

(2) *For four posts.* To place two additional posts to the *right,* set right 150 mils on the deflection scale (the vertical line of the collimator is then pointed to the left). Direct the assistant gunner to move the bipod legs until the line of the collimator is placed approximately on the left edge of the base post. Lay accurately by traversing the handwheel, cross-leveling simultaneously (1, fig. 27). Rotate the deflection knob until the scale registers zero. Then, without moving the mortar, direct No. 3 to drive the *first right post* so that its left edge is on line with the collimator (2, fig. 27). Once more rotate the deflection knob in the same direction until you have set off left 150 mils on the scale. Then direct No. 3 to drive the second right post (3, fig. 27). To place two additional

posts to the *left* of the base post, direct the assistant gunner to move the bipod legs until the line of the collimator is placed approximately on the left edge of the base post (4, fig. 27). Then repeat the process in the opposite direction. These posts are designated as the *first left post* and the *second left post*. A frontage of 900 mils is covered with four additional posts.

(3) *Additional posts*. In like manner, six (or eight) additional posts may be placed out, covering a frontage of 1,200 (or 1,500) mils.

c. Cross-Level Bubble. While placing out additional aiming posts, make sure that the cross-level bubble is centered so that accurate angles are measured by the sight.

89. Checking for Mask Clearance and Overhead Interference

a. The mortar is usually masked to the front because it is normally mounted in defilade. This mask may be a hill, trees, a building, or just a rise in the ground. In any case the gunner must be sure that the cartridge will clear the mask and

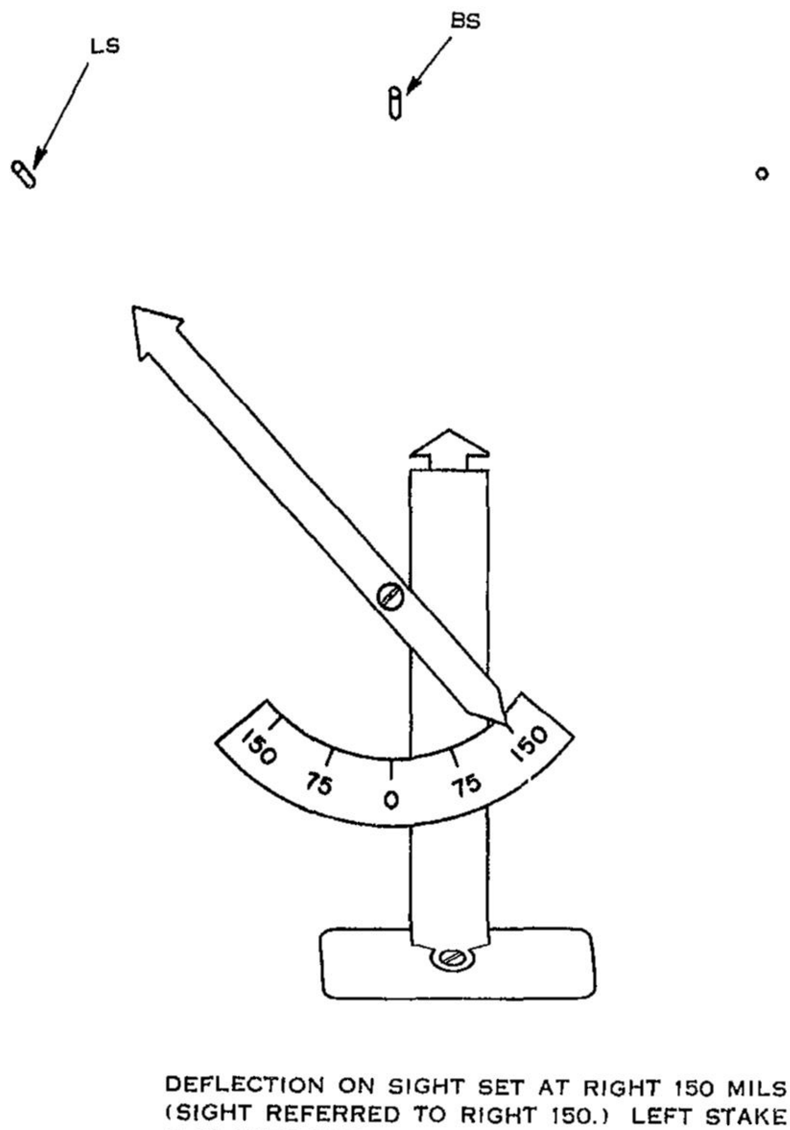
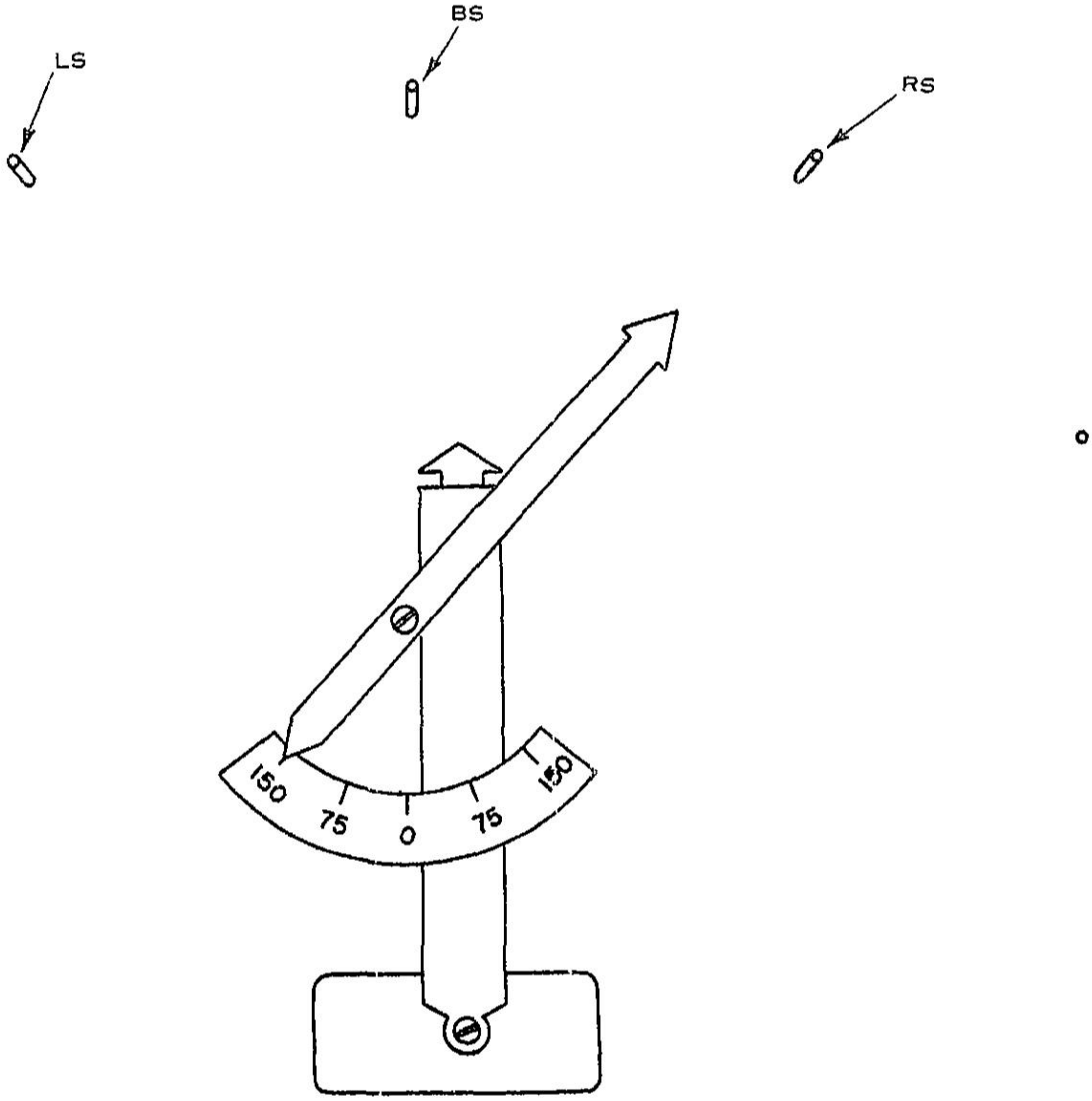


Figure 26. Placing out two additional aiming posts.



DEFLECTION SIGHT SET AT LEFT 150 MILS (SIGHT REFERRED TO LEFT 150). RIGHT STAKE IS PLACED OUT

Figure 26—Continued.

will not strike it. Also, he must be sure that there is no overhead interference by overhanging branches of trees.

b. When selecting the exact mortar position, the squad leader checks quickly by eye for mask clearance and overhead interference. After the mortar is mounted, the gunner makes a more thorough check.

c. When an elevation of 40° is set on the sight and the collimator is tilted to its extreme upward (rear) position, the line of sight through the open sight is 2° *below* the axis of the bore. To determine whether it is safe to fire a cartridge at any elevation, the procedure is as shown in (1) through (3) below:

(1) The gunner sets his sight at the desired elevation and then lays the mortar at that elevation.

(2) He then sets the sight at an elevation of 40°, tilts the collimator to the extreme rear position, and looks through the open sight. If the line of sight through the open sight clears the mask, it is safe to fire; if it does not, it is unsafe to fire.

The gunner may still fire at the desired range by selecting a charge zone that has a higher elevation for that particular range. When the line of sight does not clear the mask and no higher elevation is available, the mortar is moved to another position.

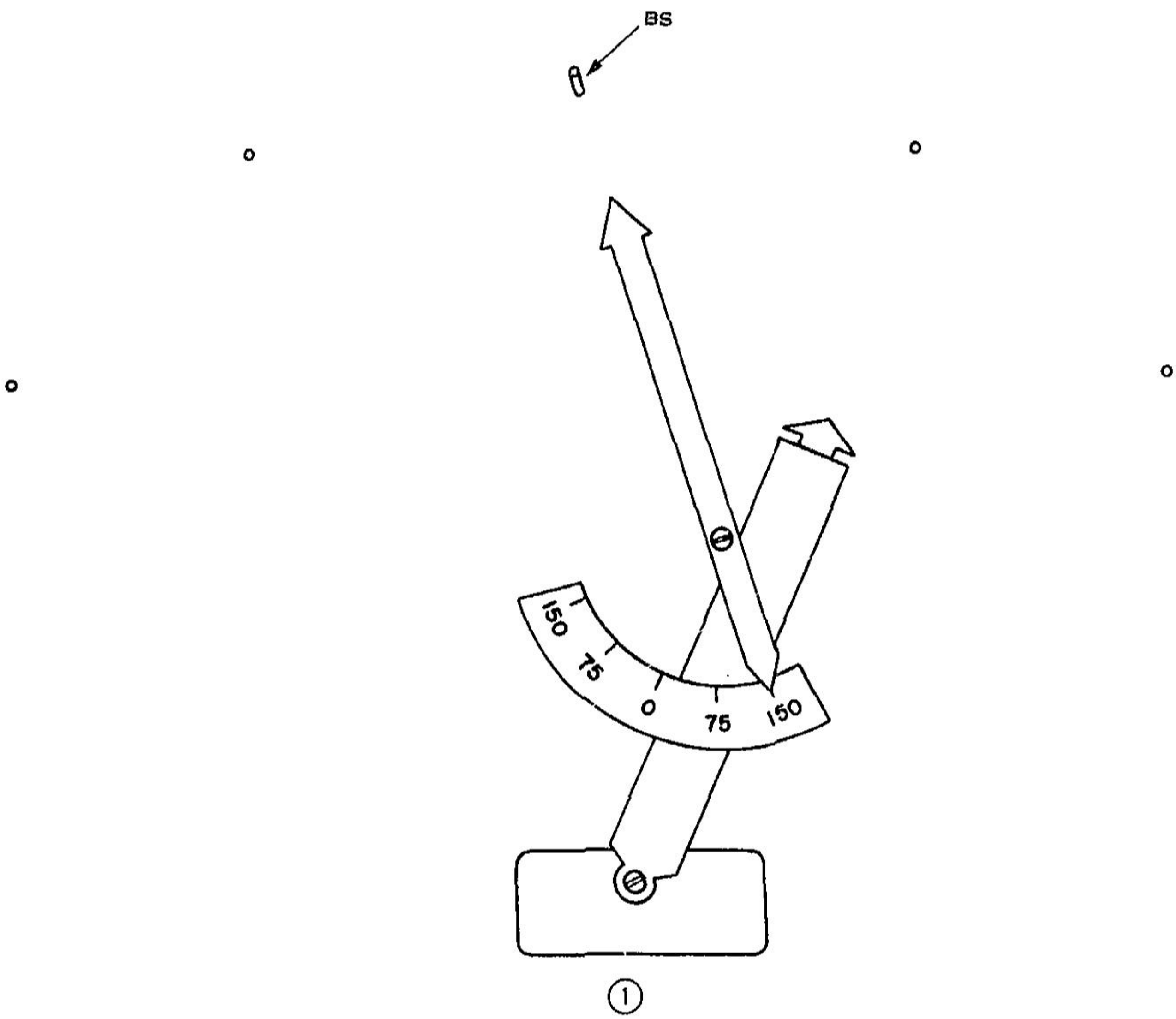
(3) The gunner makes a careful check to see that the cartridges will not pass through the branches of trees.

d. The gunner can usually determine mask clearance more quickly by sighting along the top of the barrel with his eye placed near the base cap. When it is not safe to fire, he so announces.

90. Night Firing

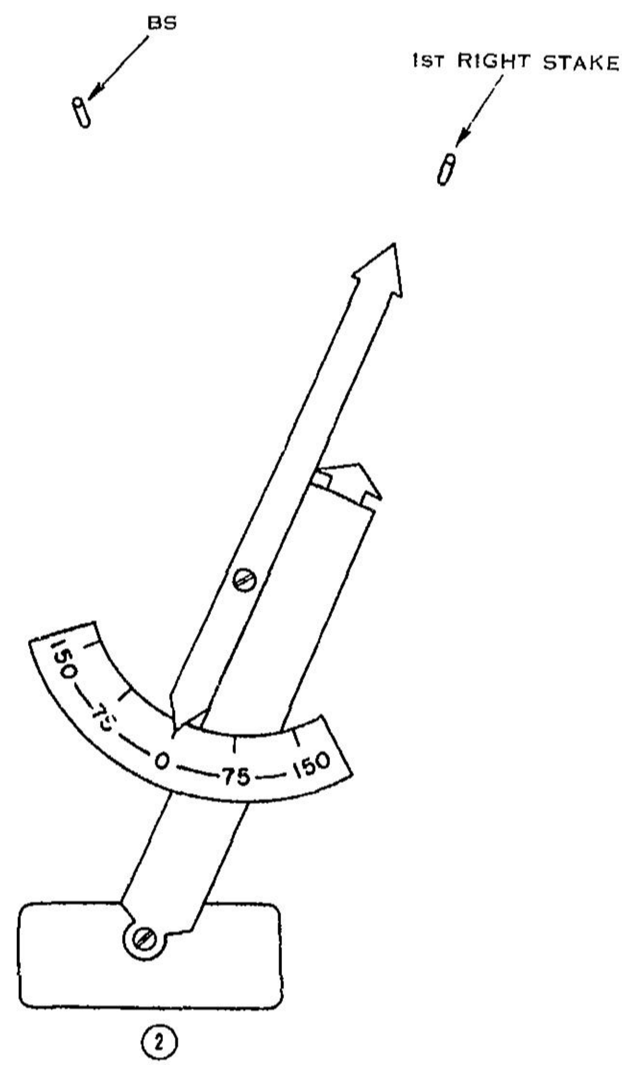
The M41 aiming post light and the M37 instrument light are used in laying the mortar at night.

a. Laying. To fire the 60-mm mortar at night, use an M10 aiming post with an M41 aiming post light as an aiming point. (When the aiming post light is turned on, a thin green vertical light filters through the lens.) Set the sight and level the bubbles by the light from the hand light of the M37 instrument light. To lay the mortar, turn on the collimator light. This causes the white line of the collimator to become visible. Then lay the white line in the collimator on the thin green vertical line of the aiming post light.



DEFLECTION SET ON SIGHT AT RIGHT 150 MILS.
MORTAR IS RELAID ON BASE STAKE.

Figure 27. Placing out four additional aiming posts.



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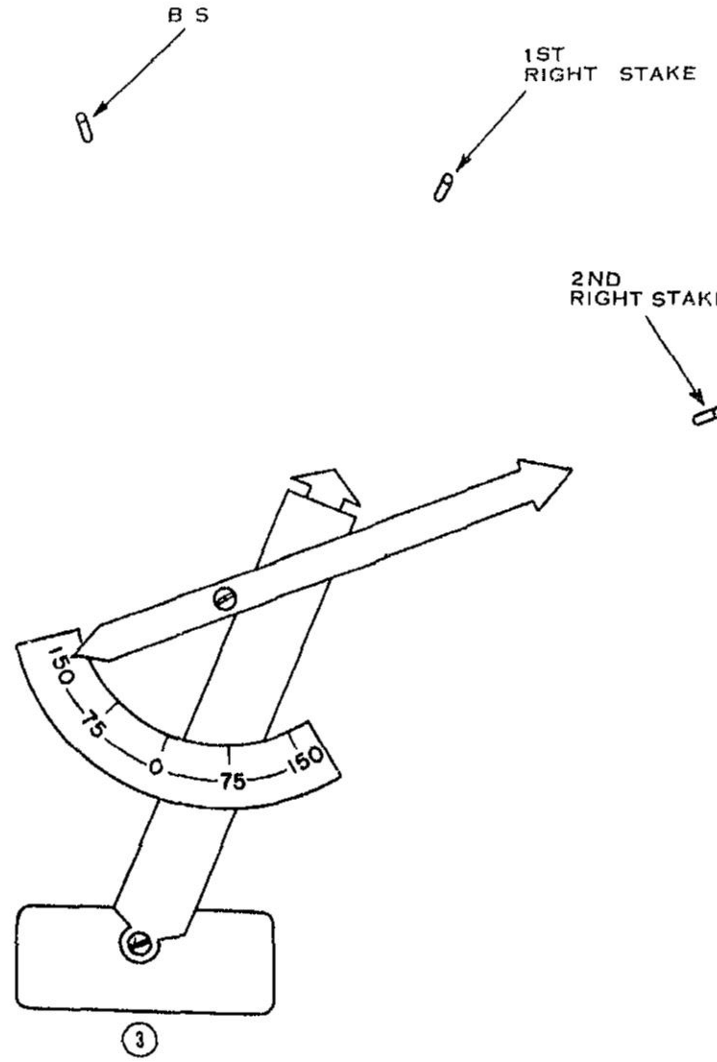
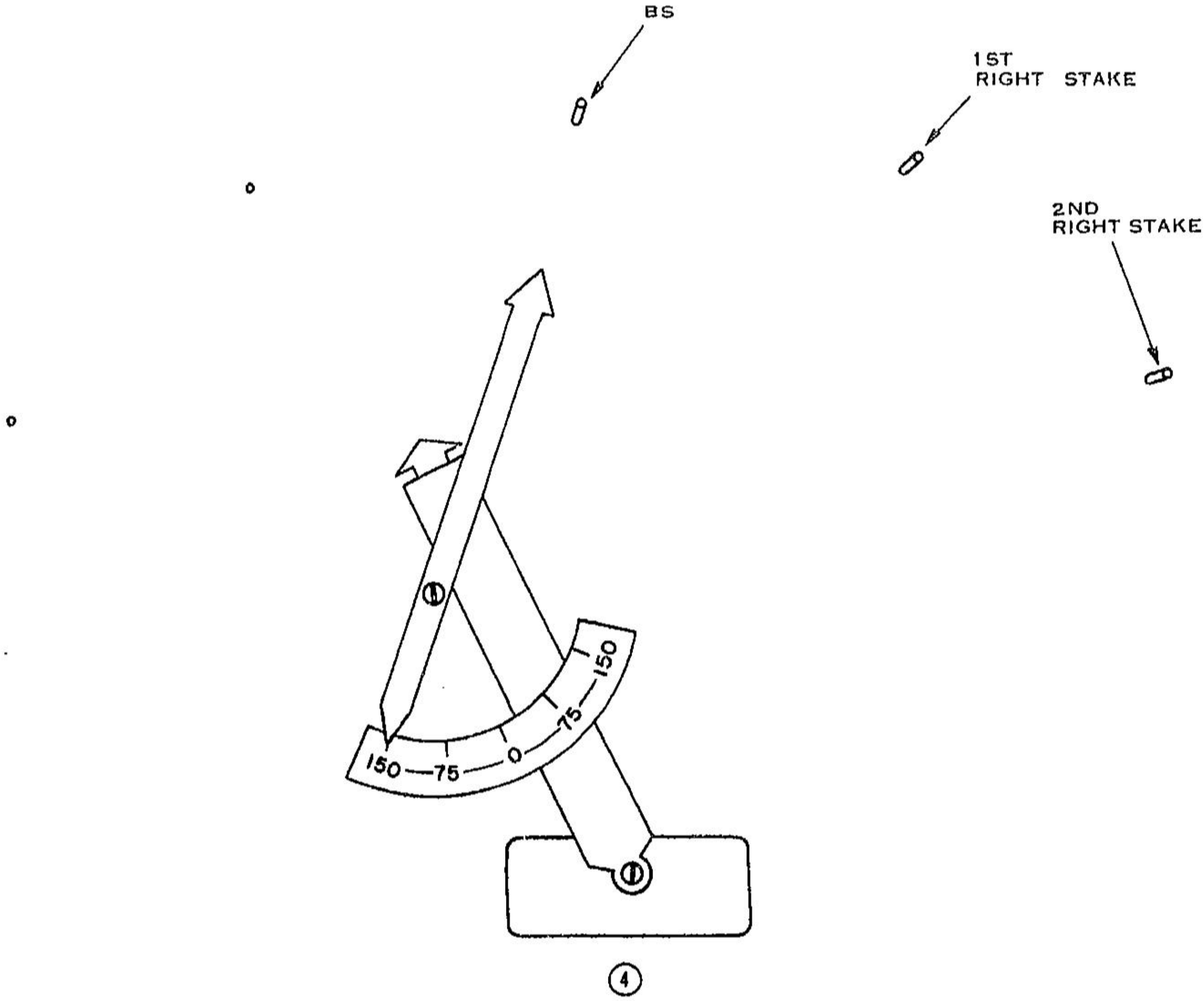
DEFLECTION OF ZERO SET ON SIGHT (SIGHT REFERRED TO ZERO.) FIRST RIGHT STAKE IS PLACED OUT.

Figure 27—Continued.



DEFLECTION OF LEFT 150 MILS SET ON SIGHT.
SECOND RIGHT STAKE PLACED OUT.

Figure 27—Continued.



WITH DEFLECTION OF LEFT 150 MILS SET ON SIGHT. MORTAR IS RELAID ON BASE STAKE BY MOVING BIPOD.

Figure 27—Continued.

b. Improvised Devices. Night firing devices may be improvised when the M41 aiming post light, the M37 instrument light, or the M10 aiming post are not available. For example, cover the lens of a flashlight with black paper and cut a thin vertical slit in the paper. Fasten the flashlight securely to the aiming post so that the lens is facing toward the mortar. When the flashlight is turned on, it illuminates the slit in the black paper covering the flashlight lens. To see the vertical line of the collimator (or the open sight), use another shaded flashlight. Prepare this light by covering the lens with black paper and piercing the paper with a small pin. Hold it just above the front of the collimator and at a slight angle so that the light falls on the front of the collimator. With a flashlight in this position, the white line of the collimator shows as clearly at night as in daylight. Also use the flashlight to see the sight scales and the level bubbles. An improvised aiming post may be used instead of the M10 aiming post.

c. Data. Firing data is prepared during daylight and recorded on a firing data sheet. When the mortar position is to be occupied at night without an opportunity to prepare data in advance, base night firing on data prepared from an aerial photograph or map. These data are only as accurate as the aerial photograph or map and the reader's skill and accuracy in reading the photo or map.

CHAPTER 5

SQUAD AND SECTION DRILL

Section I. SQUAD DRILL

91. Purpose and Scope

The primary purpose of squad drill is to train all members of the mortar squad in the duties of each member in carrying the mortar and equipment, in executing simple movements with the mortar and equipment, and in serving the mortar during firing. Therefore, assignments within the squad are rotated during the drill. In the initial phases of mortar drill, individual weapons are optional. In advanced drill, however, they are required as items of equipment. The most important consideration in mortar drill is the development of accuracy. When accuracy has been obtained, emphasis is then placed on the development of speed.

92. Training with Mortar Equipment

The various commands for controlling the initial actions of the squad are—

a. Secure Equipment. At this command, the men fall out and secure equipment as shown in figure 28 and prepare to follow the squad leader on foot. In combat, where the squad may be in any one of several formations and the equipment may be on motor or pack transport, the command is: OFF CARRIER.

b. Ground Equipment. At the original assembly with equipment, and at all halts except IN PLACE, HALT, loads are grounded without command (fig. 29).

Personnel	Secure equipment		Ground equipment	Carry equipment
	Drill	Combat		
Squad leader	Sight Binocular Compass (lensatic) Ammunition bag M2A1 (6 cartridges). Ammunition bag M1 Aiming post M10 Firing tables Flashlight	Sight Binocular Compass (lensatic) Ammunition bag M2A1 (6 cartridges). Ammunition bag M1 Aiming post M10 Firing tables Flashlight	Places ammunition bags on ground, shoulder loops to the left. Places aiming post in front of ammunition bag, spike to the left.	Puts on ammunition bags. Picks up aiming post and carries in left hand.
No. 1	Mortar (complete) Firing tables	Mortar (complete) Firing tables	Places mortar (complete) in front of him, so that the mortar barrel is up and muzzle is to the left.	Slings mortar (complete) by placing carrying strap over right shoulder in the most convenient manner.
Nos. 2, 3, and 4	1 ammunition bag (12 rounds dummy ammunition). Cleaning staff (No. 2 only). 2 aiming posts (Nos. 3 and 4 only).	1 ammunition bag (12 rounds service ammunition). Cleaning staff (No. 2 only). 2 aiming posts (Nos. 3 and 4 only).	Places ammunition bag on ground, shoulder loops to the left. No. 2 places cleaning staff in front of ammunition bag, waste end to the left. Nos. 3 and 4 place aiming posts in front of ammunition bags.	Put on ammunition bags. No. 2 picks up cleaning staff in right hand. Nos. 3 and 4 pick up aiming posts in right hand.

Figure 28. Securing, grounding, and carrying equipment.

Figure 29. 60-mm mortar squad with equipment grounded.

c. Carry Equipment. This command is given before starting any movements on foot. Loads are taken as shown in figure 30.

93. Use of Packboards

a. Packboards are provided for carrying the 60 mm mortar and ammunition for long distances. The packboards strap on the backs of the men and the mortar or 12 cartridges are carried on each packboard. Each packboard is equipped with two universal attachments and three quick-release straps (1, fig. 31).

(1) To secure the mortar to the packboard

(*a*) Lay the packboard on the ground with the attachments at 1 and 4, and with the quick release straps extending from the sides (1, fig. 31). Dismount the mortar, following the normal procedure up to the point where the left leg is moved over against the right leg. Turn the baseplate around on its socket one half turn (180°) and lay it flat against the tube on the side away from the bipod.

(*b*) Place the mortar on the packboard so that the lower edge of the baseplate rests on the bottom attachment and the legs fit in the center recesses of the upper attachment.

(*c*) Tighten the quick-release straps (2, fig. 31).

(2) To secure the ammunition to the packboard

(*a*) Place the attachments at 2 and 4.

(*b*) Remove the ammunition from the packing crates and leave it in the cardboard containers.

(*c*) Place two piles of six cartridges each on the packboard (3, fig. 31).

(*d*) Rest the bottom pile against the lower attachment of the packboard and the top pile against the upper attachment, so that the cartridges cannot slide downward during transportation.

(*e*) Bind the ammunition securely to the packboard with the upper and lower quick-release straps.

b. Examine all packs for loose straps or shifted loads each time they are shouldered. To unpack the loads lay the packs on the ground near the mortar position, and then raise the levers of the clamping buckles of the strap ends to free the straps.

Figure 30. 60-mm mortar squad with loads.

94. Movements for the Squad and Individuals

a. To Move Off. The squad having taken equipment, the squad leader commands or signals, SQUAD COLUMN. The men form in an irregular column behind the squad leader. In this formation, the squad follows the squad leader at his command, FOLLOW ME.

b. To Change Numbers. At any time during drill, the squad leader may command: FALL OUT ONE. At this command, No. 1 takes the position of No. 1 and all other numbered members of the squad move up one number. This rotation is made during drill to train each member of the squad in the duties of other members.

95. Placing the Mortar in Action

a. The squad being in any formation, to prepare the mortar to fire on a target, the command is—ACTION. The subsequent movements of the squad simulate, as much as possible, actions under combat conditions.

b. All members of the squad except the squad leader ground their loads.

c. The squad leader indicates the mortar's approximate position by placing the sight case on the ground. He then moves to his OP and gives the direction of fire by placing out an aiming post and directing the placing of a baseplate stake (direction by the direct alinement method), or by announcing the magnetic azimuth (direction by the azimuth method) (para 135 and 137).

d. When the first method is used, No. 2 drives a stake at the position indicated by the sight case and as alined by the squad leader. When the second method is used, No. 1 receives the compass from the squad leader and drives a baseplate stake at the indicated location. No. 1, using the compass, then directs No. 2 in placing an aiming post to establish the direction of fire.

e. As soon as the direction of fire is established, the mortar is mounted with the left front corner of the baseplate against the baseplate stake and with the left edge of the baseplate alined on the aiming post.

f. The squad members then take their posts as follows:

(1) *Gunner, No. 1*—Sitting, on the left side of the mortar in a position convenient to to the elevating and traversing mechanisms.

(2) *Assistant gunner, No. 2*—Prone, on the right side of the mortar, in a position from which he can load.

(3) *Nos. 3 and 4*—Echeloned, to the right and left rear, where they can supply ammunition to No. 2 and provide local security (fig. 32).

96. Safety Checks

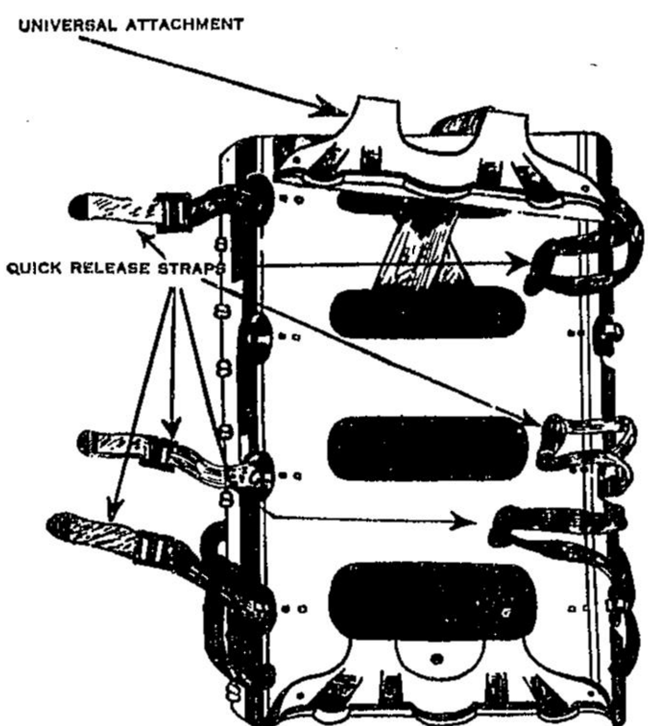
a. Before Firing.

(1) No. 1 sees that—

(*a*) There is mask and overhead clearance.

(*b*) The mortar is locked to the baseplate.

(*c*) The mortar clamp bolt is secure.



1 Packboard for 60-mm mortar loads

Figure 31. 60-mm mortar.

2 Packboard with 60-mm mortar loads

Figure 31—Continued.

(*d*) The locking nut is tight.

(*e*) The legs are fully spread and locked in that position by the spring latch.

(2) No. 2 sees that—

(*a*) The bore is clean.

(*b*) Each cartridge is clean—particularly the gas check band (fig. 14).

(*c*) The safety pin and striker spring of each cartridge are present.

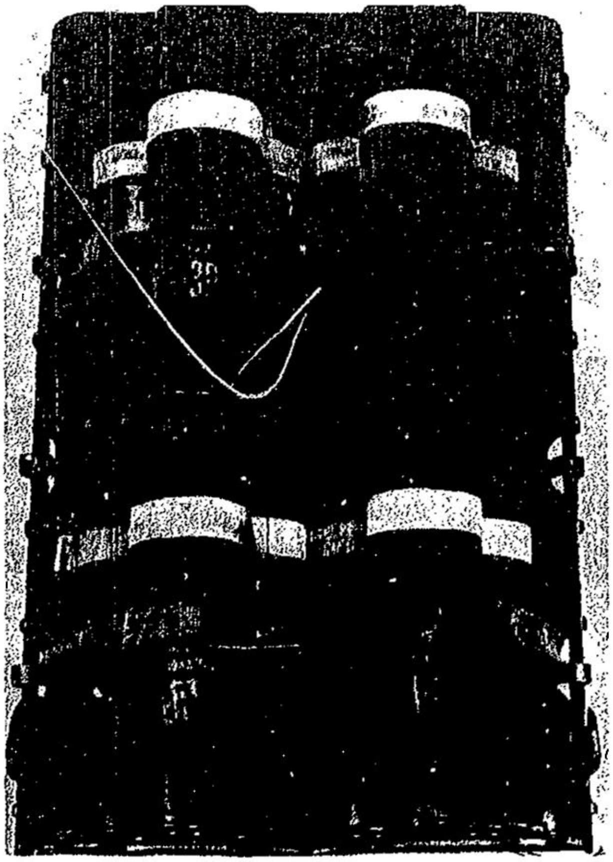
b. During Firing.

(1) No. 1—

(*a*) From time to time checks the clamp bolt and locking nut to see that they are tight.

(*b*) Checks frequently to see that the baseplate and bipod positions are safe for firing.

(2) No. 2—



3 Packboard with 60-mm mortar ammunition load

Figure 31—Continued.

Swabs the bore after every fire for effect or after every ten cartridges.

97. To Fire the Mortar

a. Squad Leader. The leader gives an initial fire command.

b. Gunner No. 1.

(1) Repeats the fire command.

(2) Sets the deflection on the sight.

(3) Looks up the elevation and charge and announces the correct charge to No. 2.

(4) Sets the elevation on the sight.

(5) Lays for elevation (fig. 33).

(6) Lays for direction and cross-levels simultaneously.

(7) Removes the sight before firing the first three cartridges, or until the baseplate is firmly seated.

(8) Checks the firing selector to see that it is set on DROP FIRE.

(9) Places his left hand on the left leg of the bipod and his right hand around the base cap to steady the mount and assist the seating of the baseplate during the firing of the first three cartridges (fig. 34).

(10) Commands: FIRE.

c. Assistant Gunner (No. 2).

(1) Repeats command designating charge.

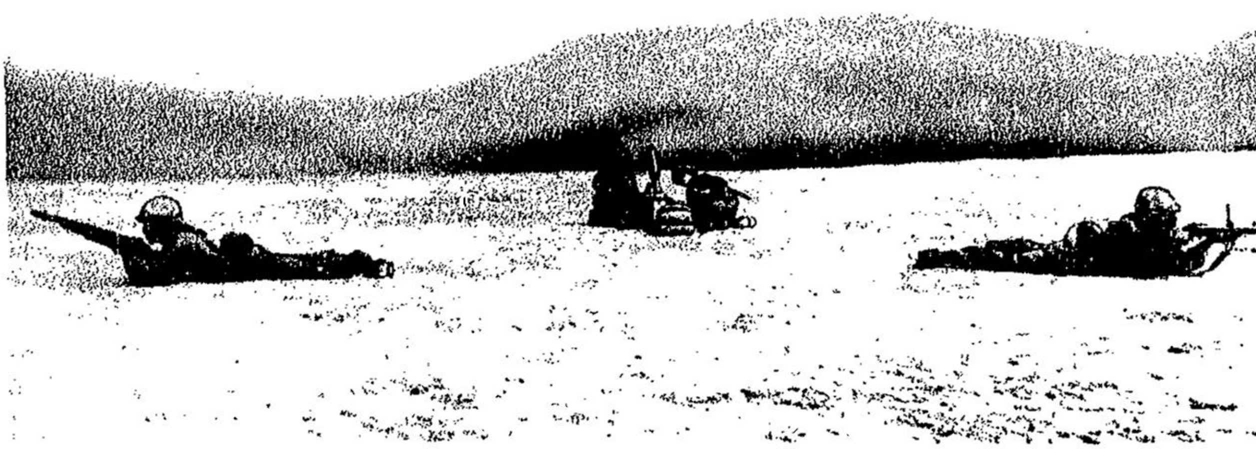


Figure 32. Disposition of the 60-mm mortar squad in action.

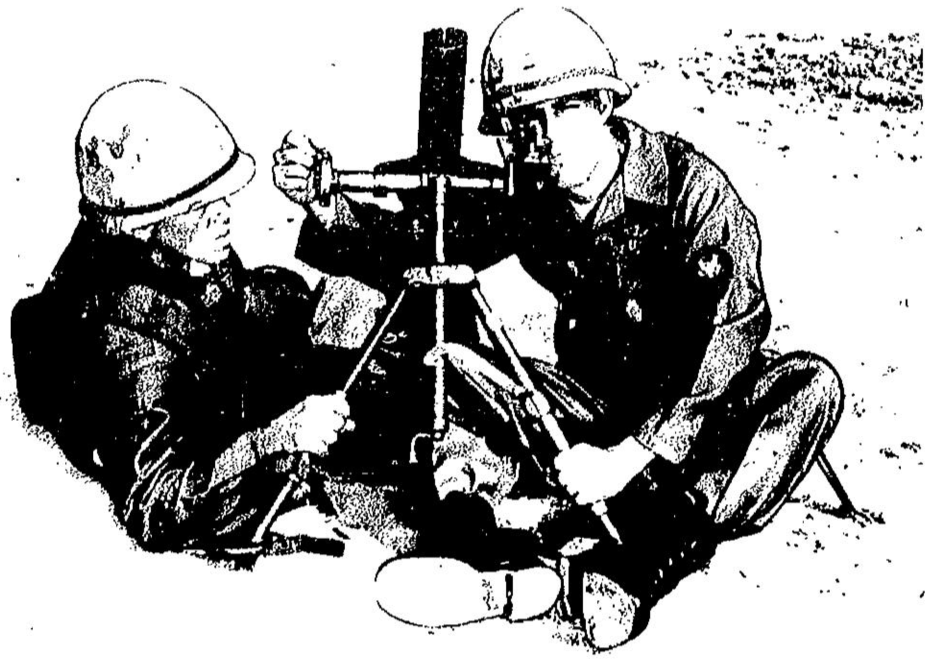


Figure 33. Gunner's position at mortar.

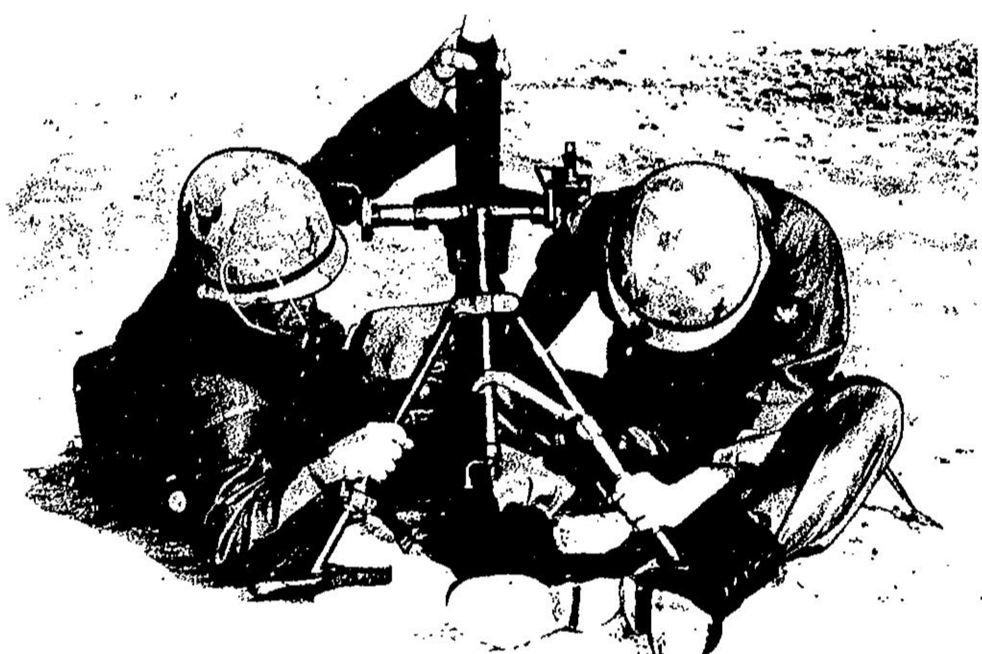


Figure 34. Assistant gunner inserting cartridge.

(2) Secures an unpacked cartridge and checks for the presence of the safety pin. If it is not present, the cartridge is not fired.

(3) *Holds the cartridge in the vertical position with the fuze end up.* Withdraws the safety wire and tests the tension of the safety spring by pressing and releasing the safety pin with his thumb. If the safety pin becomes unseated, the cartridge is armed; such cartridges are placed in a safe location to be destroyed by supporting maintenance unit personnel.

Caution: Do not fire armed cartridges because they may detonate in the mortar barrel. Armed cartridges must be handled with care because they might be detonated by pressure on the striker.

(4) Tests for pressure of the fuze striker spring by pressing the striker head with the thumb of his left hand.

(5) Removes the necessary number of powder increments to leave the announced charge in place.

(6) Places his right hand on the right leg of the bipod to steady the mount during the firing of the first three cartridges.

(7) At the gunner's command FIRE, he grasps the cartridge with his left hand around the gas check band and inserts the cartridge, fuze end up, in the muzzle of the mortar (fig. 34). Upon releasing the cartridge, he immediately withdraws his hand to the rear and lowers his head away from the muzzle of the mortar.

d. Nos. 3 and 4. Remove the cartridges from the ammunition bags and containers and pass the cartridges to No. 2 as he directs, and then take positions to afford local security for the gunner and assistant gunner.

98. Misfires

a. General. A misfire occurs when a cartridge is loaded into the barrel but fails to fire. Usually, the cartridge strikes the firing pin but fails to function. In rare cases, the cartridge may hang in the barrel without striking the firing pin. Frequently during mortar drill, when the squad is simulating firing with dummy cartridges, the squad leader should announce MISFIRE and order the mortar crew to remove the misfire.

b. Removal of Cartridge After Misfire.

(1) No. 1 kicks the barrel with his heel. This may dislodge a cartridge that is stuck in the barrel; if the cartridge is fired, the mortar is relaid and firing is continued. If the cartridge is not fired, No. 2 then sets the firing selector on LEVER FIRE and trips the lever three times. If the mortar still fails to fire, the crew waits at least 1 minute before removing the cartridge to avoid an accident caused by a possible delayed action of the propelling charge. During this period, No. 1 tests the barrel for heat. If the barrel is cool at the end of 1 minute, the cartridge is removed as described below. If the barrel is hot, pour water on the outside of the barrel until it is cool. If no water is available, all personnel stand clear of the mortar until it is cool.

(2) No. 1 rises to a kneeling position and unlocks the mortar from the baseplate, braces the bipod by placing his left arm in front of the legs, and grasps the right leg at the handgrip. He places his right hand around the base cap. He is careful to keep his head and shoulders from in front of the muzzle. No. 2, from a kneeling position, places his right hand, palm up, under the barrel, and his left hand, palm down, on top of the barrel. He places his thumbs alongside the forefingers. He is careful to keep every part of each hand from in front of the muzzle. No. 1 lifts the base of the barrel until the barrel is horizontal (fig. 35). *Under no circumstances does he again lower the base of the mortar below a horizontal position until the cartridge has been removed from the barrel.* As soon as the barrel has reached the horizontal position, and *not before*, No. 2 places the thumb of each hand over the muzzle and stops the cartridge as the point of the fuze reaches the muzzle. He then removes the cartridge from the barrel, and inspects it for the presence of the safety pin. If the safety pin is not present, he places the cartridge to one side for disposal by the supporting maintenance unit. If the safety pin is present, he replaces the safety wire. He then determines the cause of mis-

Figure 35. Removal of a misfire.

fire for this cartridge. If the ignition cartridge is dented the cartridge is placed aside for destruction. If the primer is undented, the cartridge may be refired after the mortar is remounted. No. 1 raises the base of the barrel well above the muzzle and shakes the barrel to dislodge any remnants from the last cartridge fired.

(3) Then No. 1 lowers the mortar and locks the spherical projection in the socket. He sets the selector on DROP FIRE and firing is resumed. If another misfire occurs, No. 1 inspects the firing pin to see that it is clear and protruding beyond the surface of the firing pin bushing. If the firing pin is found to be faulty, the firing mechanism is disassembled and the defect corrected.

c. Causes of Misfire. The propelling charge may not function because of—

(1) Defective primer or ignition cartridge.
(2) Defective or damaged firing pin or other parts of firing mechanism.
(3) Loose firing pin bushing.
(4) Firing pin fouled or obstructed by remnants from previous cartridges.
(5) Fouled bore.
(6) Excess oil or water in bore.
(7) Cartridge not fully inserted in fin assembly.
(8) Misalined stabilizing fin.
(9) Foreign matter or excess paint on the gas check band.

99. Out of Action

The normal method of taking the mortar out of action is to leave the baseplate attached to the

mortar, so that the mortar can be carried as one unit and be placed in action again quickly.

a. The squad leader commands: OUT OF ACTION. The gunner hands the sight to the squad leader and dismounts the mortar.

b. All squad members secure their equipment and form as the squad leader directs.

c. When the mortar is to be carried a considerable distance, the squad leader may command: OUT OF ACTION, TWO-MAN LOAD. The gunner removes the baseplate so that it can be carried by any member of the squad designated by the squad leader.

d. The squad is trained in the rapid occupation of alternate firing positions. The gunner leaves the baseplate and the sight attached to the mortar and carries it in the most convenient manner to the new firing position.

100. Exercises in Squad Drill Without a FDC

a. To control the initial actions of the squad in squad drill, the squad leader commands: SECURE EQUIPMENT, CARRY EQUIPMENT, SINGLE (TWO-MAN) LOAD, SQUAD COLUMN, FOLLOW ME.

b. To prepare the mortar to fire on a target, the squad leader commands: ACTION. The squad goes into action making the prefiring safety checks. When the mortar is mounted and ready for action, the gunner announces: NUMBER ONE UP.

c. The squad leader issues a series of commands as would be issued in an actual situation. The squad uses dummy (wooden) ammunition (with a string attached for ease in removing the cartridge), and executes the commands in the manner outlined in paragraph 97. (These commands are prepared in advance and written on cards.) The squad leader checks the lay of the mortar before issuing the next fire command. Here is an example of a series of fire commands:

NUMBER ONE
HE
ONE ROUND
ZERO, BASE STAKE
EIGHT SEVEN FIVE

RIGHT ONE FIVE
SIX SEVEN FIVE

LEFT ONE ZERO
SEVEN SEVEN FIVE

LEFT FIVE
EIGHT TWO FIVE

THREE ROUNDS
EIGHT HUNDRED

d. After the first problem is completed, the squad leader orders the squad to mark base deflection and to place out additional aiming posts by commanding: MARK BASE DEFLECTION PLACE OUT ADDITIONAL AIMING POSTS. The gunner moves the bipod legs until the line of the collimator is placed approximately on the left edge of the base aiming post. He lays accurately by traversing and cross-leveling simultaneously. He rotates the deflection knob until the scale registers zero. Then, without moving the mortar, he directs No. 2 to drive the *first right post*, so that its left edge is on line with the collimator. He once more rotates the deflection knob in the same direction until he sets left 150 mils on the scale. No. 2 then drives the *second right post.* To place two additional posts to the left of the *base post*, the gunner, with a sight setting of left 150 mils, moves the bipod legs until the line of the collimator is approximately on the left edge of the base post. He then repeats the process in the opposite direction. These posts are designated as the *first left post* and the *second left post.* A frontage of 900 mils can be covered with four additional aiming posts.

Section II. PLACING HANDHELD MORTAR IN ACTION

101. General

Since the mortar may be used as a direct fire weapon by attaching the small M1 baseplate to the barrel, each squad member is trained in the procedure for placing it in action and the correct firing positions. The handheld mortar is normally manned by a crew of two men. The equipment required for the drill with the handheld mortar is the mortar, complete with carrying strap, cleaning staff, and two ammunition bags, one loaded with 12 cartridges of dummy ammunition and one loaded with 6 cartridges (fig. 36).

102. Placing the Mortar in Action

a. Kneeling Position. The kneeling position is used for low trajectory fire (whenever the mortar is held at 45° elevation or less).

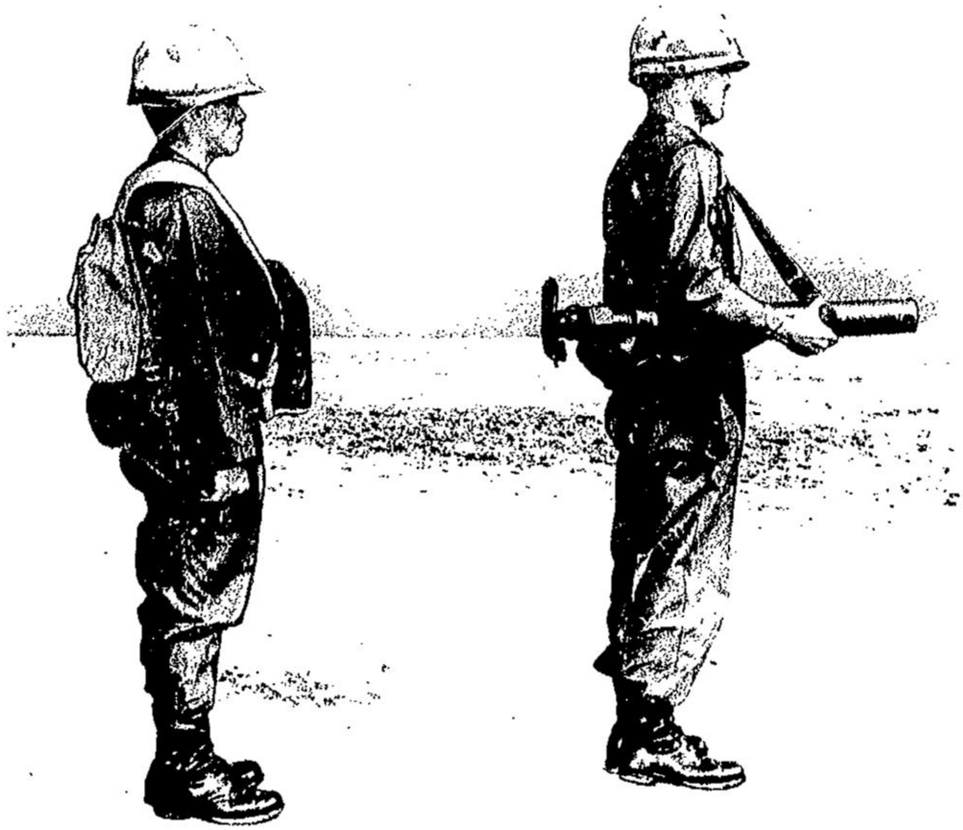


Figure 36. Handheld mortar team with loads.

(1) *Gunner No. 1.* At the command ACTION the gunner unslings the mortar from his shoulder and places it on the ground at the designated site with the muzzle pointed in the direction of fire. He then removes the ammunition bag (containing six cartridges) and places it to the right of the mortar. Picking up the mortar with the firing lever up and to the left, the gunner removes the muzzle cover and seats the baseplate by lifting the mortar and jamming the baseplate into the ground 2 or 3 times. He estimates the range to the target and announces CHARGE ONE (ZERO) to No. 2. (See para 165 for the method of determining the elevation and charge.) He then assumes the correct kneeling position (fig. 37) by kneeling on his left knee, placing his right foot on the baseplate, and supporting the mortar with his right hand approximately halfway up the barrel. He then checks the firing selec'or to see that it is set on LEVER FIRE. He announces LOAD to No. 2 and as sooon as the cartridge has slid down to the bottom of the barrel, he alines the barrel for direction by sighting over the barrel and raises or lowers the barrel to the estimated elevation to hit the target. With his left thumb he presses the lever and fires.

(2) *Assistant gunner No. 2.* At the command ACTION, the assistant gunner places the cleaning staff beside the ammunition bag which was placed to the right of the mortar by the gunner. He does not remove his own ammunition bag which contains 12 cartridges. He takes a position lying on his right side facing the mortar and removes three cartridges from the gunner's ammunition bag. He removes excess powder increments according to the

charge announced by the gunner, removes the safety wire and tests for the presence of a safety pin and striker spring. Upon the command LOAD from the gunner, he places one cartridge in the mortar barrel fin end first (fig. 38), and gives it a slight push to help it slide down the barrel.

b. Sitting Position. The sitting position is used for high trajectory fire (whenever the mortar is held at an elevation of more than 45°). The drill for placing the mortar in action for the sitting position is the same as for the kneeling position with the exception that the gunner, instead of kneeling, sits with the mortar between his legs (fig. 39). Either DROP or LEVER fire may be used when holding the mortar in this position. When drop fire is used, the gunner may load the piece himself.

c. Removal of Cartridge After Misfire.

(1) The gunner raises the mortar to a higher elevation and jars the barrel with his free hand. He then sets the firing selector on lever fire, if it is not already set on lever fire, and trips the lever several times. If the mortar still fails to fire he waits at least 1 minute before removing the cartridge.

(2) To remove the cartridge, the gunner places his right hand around the base cap and his left hand around the barrel about halfway between the muzzle and the base cap. With the assistance of No. 2, he proceeds with the removal of the misfire as explained in paragraph 99*b*(2).

103. Safety Checks

Before and during firing the handheld mortar—

a. No. 1 sees that—

(1) The firing selector is set correctly. (Lever fire for low angle firing.)

(2) The area directly in front of the mortar is clear of brush, weeds, and limbs.

b. No. 2 sees that—

(1) The bore is clean.

(2) Fuze safety wire and pin are present.

(3) Each cartridge is clean—particularly the gas check band.

Figure 37. Kneeling position, handheld mortar.

Figure 38. Loading the handheld mortar from the kneeling position.

Figure 39. Sitting position handheld mortar.

104. General

The section leader conducts section drill. In general, this drill differs from squad drill only in that more than one mortar is used, and they are laid parallel for direction. Normally, the entire section of 60-mm mortars (three squads) participates in section drill. The fire commands are prepared in advance and written on cards. New sets of commands are prepared from time-to-time to prevent the squads from anticipating commands and to vary the drill. The main duty of the section and squad leaders during the drill is to detect and correct incorrect procedures and errors in laying.

105. Laying the Section Parallel

a. The sheaf of fire of a section is the pattern that a round fired from each mortar at the same time makes on the ground. A parallel sheaf is desired for the section. In a parallel sheaf the interval between bursts is the same as the interval between mortars. The first requirement in obtaining a parallel sheaf is to lay all mortars parallel initially.

b. Initial direction for the base mortar (normally No. 2) is obtained by the azimuth method using a compass to aline the mortar on the desired azimuth. For establishing initial direction with a compass, see paragraph 82.

c. The remaining mortars of the section are mounted parallel to the base mortar by laying them in the desired direction of fire using the same compass used to lay the base mortar.

d. The mortars are located on a 60–70 meter front, 30–35 meters between mortars. In a section firing position, the mortars are numbered from the right to left, facing the direction of fire, irrespective of their regular squad members.

106. Exercises in Section Drill Without a FDC

The section is in any formation to the rear of the firing position. Each squad carries equipment as indicated in figure 29.

a. The section leader, having received or determined the desired direction of fire and selected the exact firing position for each mortar, initiates the drill by commanding: SQUAD LEADERS AND NUMBER TWO's FORWARD.

b. The section leader moves immediately to the position selected by him for the base mortar. On the above command, the squad leaders and number two's move to positions to the rear of the section leader.

c. The section leader indicates (by pointing) the general direction of fire and commands: SQUAD LEADER, SECOND (BASE) SQUAD, DRIVE YOUR BASEPLATE STAKE HERE (pointing). While the squad leader drives the baseplate stake into the ground, number two of the base squad moves 25 meters to the front and faces in the direction of the section leader.

d. The section leader places his compass on the baseplate stake for the base mortar, orients his compass on the desired azimuth, and directs No. 2 in placing the aiming post (base stake) to establish the direction of fire. (He makes sure that no metallic equipment is within 10 meters of the position.)

e. As soon as the direction of fire for the base mortar is established, the section leader commands: NUMBER ONE, FOLLOW ME, and the squad leader and No. 2 of the first squad move with the section leader to the position selected by the section leader for the first squad. The section leader then establishes the direction of fire for No. 1 in the same manner as for the base mortar. Simultaneously the squad leader of the second squad commands: ACTION, and the mortar is placed into action as described in paragraph 102.

f. The section leader moves to the position he selected for the third squad and establishes the direction of fire in the same manner as for the base mortar. As soon as the direction of fire has been established, each squad leader commands: ACTION.

g. When each mortar is mounted, each squad leader checks the lay of his mortar and when satisfied announces to the section leader: NUMBER (ONE) (TWO) UP.

h. The section leader then issues a series of commands (prepared in advance). Dummy (wooden) ammunition is used by each squad, if available. During the adjustment, the crews of the nonfiring mortars follow the commands (place the deflection and elevation announced in the fire commands on the mortars but do not simulate firing). All mor-

tars designated by the section leader simulate fire for effect. An example of such a series of fire commands is as follows:

SECTION
HE
NUMBER TWO
ONE ROUND
LEFT FOUR ZERO, BASE STAKE
EIGHT HUNDRED

LEFT TWO ZERO
SEVEN HUNDRED

RIGHT FIVE
SEVEN FIVE ZERO

SECTION
FIVE ROUNDS
SEVEN SEVEN FIVE
FIRE

i. After the first problem is completed, the section leader orders the section to mark base deflection and to place out additional aiming stakes by commanding: MARK BASE DEFLECTION PLACE OUT TWO (FOUR) ADDITIONAL AIMING STAKES. The section leader continues the drill by issuing additional series of fire commands. He designates another mortar as the adjusting mortar for each new series of fire commands.

CHAPTER 6

GUNNER'S EXAMINATION

Section I. PREPARATORY INSTRUCTION

107. General

The purpose of preparatory instruction is to train the individual soldier to perform accurately the duties of the gunner in firing the mortar. The training consists of exercises that require the soldier to perform the gunner's duties in a prescribed manner.

108. Method of Instruction

a. The applicatory method of instruction is used throughout. First, the conditions and requirements of each step of the qualification course are explained and demonstrated. Under supervision of group instructors, every man is given practical work in each step. Accuracy is stressed from the start; speed is attained through repetition.

b. The officer in charge of the instruction details the assistant instructors. The squad leaders usually act as group instructors.

c. Upon completion of the explanation and demonstration of each of the instructional exercises, the groups are returned to their equipment, where the assistant instructors conduct the practical work.

109. Prior Training

A man is not given instruction in the gunner's examination until he has become proficient in mechanical training, in the appropriate portions of crew drill, and in fire commands and their execution.

110. Preparatory Exercises

The preparatory exercises of the gunner's examination consist of training in the various subjects of the qualification course listed in paragraph 113. Examination in the subjects of the qualification course (Gunner's Examination) (DA Form 3214–R) is given after preparatory instruction is completed. If training time is available, those initially failing the gunner's examination may continue their training until they qualify on a subsequent test. The progress of each soldier in the preparatory instruction is noted by the instructor on a progress chart (fig. 40).

Section II. EXAMINATION

111. Grades and Basis of Qualification

The individual soldier's proficiency with the mortar is indicated by classifying him as an expert gunner, a first-class gunner, a second-class gunner, or as unqualified. The unqualified class includes those men who have been examined and who have failed to qualify as second-class gunner or better. It also includes all others who are required to take the gunner's examination, but who, for any reason, have not been examined Examinations are held as required to determine the proficiency and qualification of the men undergoing instruction.

112. Examining Boards—Appointment, Composition and Duties

The examination is conducted by a board of three or more officers, who are qualified mortar instructors. Boards are appointed by the commanders having authority to issue qualification orders. The president of the board supervises the conduct of the examination. He is the final authority when any question arises during the examination. The remaining members actually conduct the examination. As a general guide, four men can be tested at one mortar in a 4-hour period.

NAME	MOUNTING THE MORTAR	LAYING MORTAR WITH INITIAL FIRE DATA	RE-LAYING THE MORTAR FOR CHANGES IN FIRE DATA	MARKING BASE DEFLECTION	LAYING MORTAR ON AIMING STAKES	MANIPULATION OF MORTAR FOR TRAVERSING FIRE
Sgt. Brown L	XX XX	XXX	XXXXX	XXX	XX XX	XXXXX
Sp/4 Dade, M	XXX	XX XX	XXX	XX XX	XX XX	XX XX
Pfc. Hall, A.P	XX XX	XXX	XXX	XX	XX XX	XX XX
Pvt. Wilbur G.E.	XXX	XX	XX	XXX	XX XX	XXX
Pvt. McCarty, C	XX	XXX	XX XX	XX	XXX	XXX
Pvt. Flynn, R.O	XXX	XX	X	XX	X	XXX

X	XX	XXX	XX XX	XXXXX
FAIR	GOOD	VERY GOOD	EXCELLENT	EXCELLENT AND HAS INSTRUCTIONAL ABILITY

Figure 40. Progress chart, 60-mm mortar marksmanship.

One officer can handle three mortars at the same time with an assistant instructor at each mortar.

113. Examination Subjects

Maximum credits for tests	*Value*
Mounting the mortar	40
Laying the mortar with initial fire data	30
Relaying the mortar for changes in fire data	30
Marking base deflection	30
Laying mortar on additional aiming post	30
Manipulation of the mortar for traversing fire	40
Total possible credit for test	200

114. Qualification Scores for 60-MM Mortar

Qualification	*Score*	*Percent*
Expert Gunner	180	90
1st Class Gunner	160	80
2d Class Gunner	140	70
Unqualified	Less than 140	Less than 70

115. General Rules Governing Examining Boards

The following rules govern examining boards:

a. The conditions of the examination are made as nearly uniform as possible for all candidates. The board is responsible for safeguarding information contained in examinations. It makes sure that a candidate who takes a test does not pass on data contained in the test to another candidate; it also makes sure that no candidate receives the benefit of a sight setting or a mortar laid by another candidate.

b. The board does not give ranges to the candidate that will require him to make more than 10 turns of the elevating crank. As the mortar is laid initially with an elevation of 62° in each of the steps in which a range is given, only ranges with elevation of 57° to 67° inclusive may be given.

c. Should any candidate fail in any trial through the fault of an examiner or an assistant, or because of the failure or malfunction of the sight or other instrument used, that trial is disregarded and the candidate is given another trial.

d. The candidate selects the assistants he is authorized.

e. Each candidate is given the tests in the order in which they are described in paragraphs 117 through 122.

f. In any test requiring the candidate to lay for elevation or to cross-level the mortar, the board considers the position of the bubble in either the longitudinal or cross-level vial to be correct if the bubble is inside or tangent to the outside etched lines on the glass tube.

g. When, because of excess play, a mortar has failed to maintain the lay after the candidate has called UP or FIRE, a member of the board twists the mortar (taking up the play without manipulation) until the vertical line of the collimator is again alined on the stake. If the cross-level bubble is correct at this point, the candidate is given full credit for that trial, provided the other conditions are correctly fulfilled.

h. The board makes sure that no unauthorized assistance is given the gunner during the examination. The gunner has been trained for combat performance of his duties and is tested with this thought in mind.

i. If the examination is given using either the M34A2 or M53 sight units, see FM 23–90 or FM 23–92 for a full explanation.

Section III. QUALIFICATION COURSE

116. General

This section gives the requirements of the qualification course (Gunner's Examination) (DA Form 3214–R). The test is divided into six steps as listed in paragraph 113. Each step is run twice. DA Form 3214–R will be reproduced locally in 5¼″ by 8″ paper (fig. 41).

117. Step I—Mounting the Mortar

a. Equipment.

(1) *For candidate.* Complete mortar with sight and two aiming posts.

(2) *For testing officer.* Stopwatch and DA Form 3214–R.

b. Conditions.

(1) Two stakes are driven about 25 meters apart; one designates the mortar position and the other indicates the direction of fire.

(2) The mortar is laid out on the ground at the position where it is to be mounted (indicated by a stake). The baseplate is attached to the spherical projection and the legs are strapped to the barrel. The sight, in a latched case, is placed near the mortar. The candidate takes up a kneeling position to the left of and on line with the mortar.

(3) Each candidate is given two trials.

GUNNER'S EXAMINATION
60-mm Mortar
(FM 23-85)

Name: Hall, R. S.				Grade: Sp/4
Date: 4 Aug 66		Unit: A Co. 15th		
		Time	Points	Score
Mounting Mortar	1	58	16	36
	2	48	20	
Laying With Initial Data	1	23	15	30
	2	22	15	
Re-laying For Changes In Firing Data	1	24	0	15
	2	23	15	
Marking Base Deflection	1	45	15	30
	2	50	15	
Laying On Additional Stake	1	40	11	26
	2	34	15	
Manipulation For Traversing Fire	1	45	20	40
	2	43	20	
			TOTAL SCORE	177
Qualification: 1st Class Gunner				
Verified: Lt Charles J Davis				

DA FORM 3214-R, 1 Feb 67

Figure 41. Scorecard, 60-mm mortar qualification course.

c. Procedure.

(1) The candidate executes the premounting check to see that—

(*a*) There is one finger clearance on the unpainted surface of the left leg below the adjusting nut.

(*b*) The locking nut is not tight (or too loose).

(*c*) The traversing bearing is centered.

(*d*) The binding strap is not entangled.

(2) When the candidate is ready to mount the mortar, a member of the board gives the command for mounting the mortar. For example, TO YOUR FRONT, ACTION.

(3) At this command, the mortar is mounted, with the sight attached, and laid on the left edge of the aiming post, as prescribed in paragraph 13.

(4) As soon as the mortar is mounted and laid, the candidate calls UP.

(5) Time is taken from the command ACTION to the announcement UP by the candidate.

d. Scoring.

(1) No credit is given if the—

(*a*) Time exceeds 75 seconds.

(*b*) Sight is not set correctly for deflection (zero) and elevation (62°).

(*c*) Mortar is not correctly laid for elevation (longitudinal level bubble not centered).

(*d*) Mortar is not cross-leveled (cross-level bubble not centered).

(*e*) Vertical line of the collimator is more than 5 mils off the left edge of the aiming post.

(*f*) Traversing mechanism (bearing) is more than two turns to the left or right of the center position.

(2) When the mortar is found to be correctly laid within the limits prescribed, credit is given as follows:

Time in seconds	50 or less	51–55	56–60	61–65	66–70	70–75
Credits	20	18	16	14	12	10

Total possible score (two trials) ---------- 40

118. Step II—Laying the Mortar with Initial Fire Data

a. Equipment.

(1) *For candidate.* Complete mortar with sight, one aiming stake, and firing table.

(2) *For testing officer.* Stopwatch and DA Form 3214–R.

b. Conditions.

(1) The mortar is mounted as described in paragraph 12 with a base stake placed approximately 25 meters from the mortar position. The mortar is laid on the aiming post with the sight set at zero deflection and the traversing mechanism (bearing) approximately centered. The elevation scale is set at 62° and the longitudinal and cross-level bubbles are centered.

(2) For each trial, the candidate takes the gunner's position on the left of the mortar and checks to see that it is mounted correctly and laid as described. If the candidate desires, he may start this test with his left hand on the deflection knob of the sight.

(3) The amount of deflection given does not exceed 60 mils and the range given does not require an elevation less than 57° or greater than 67°.

(4) Each candidate is given two trials.

c. Procedure.

(1) When the candidate is ready to receive the command, an initial fire command is announced by the testing officer. For example: NUMBER ONE, HE, ONE ROUND, RIGHT FIVE ZERO, BASE POST, EIGHT HUNDRED.

(2) The candidate repeats each element of the fire command, sets the sight with the given deflection, looks up the elevation and charge for 800 meters, announces the correct charge, lays the mortar for elevation, and relays on the left edge of the aiming stake, cross-leveling simultaneously. As soon as the mortar is laid, the candidate commands: FIRE.

(3) Time is taken from RANGE in the fire command to the command FIRE by the candidate.

d. Scoring.

(1) No credit is given if the—

(*a*) Time exceeds 40 seconds.

(*b*) Sight is set incorrectly for elevation or deflection.

(*c*) Mortar is not correctly laid for elevation.

(*d*) Mortar is not cross-leveled.

(*e*) Vertical line of the collimator is more than 5 mils off the left edge of the aiming post.

(2) When the mortar is found to be laid correctly within the limits prescribed, credit is given as follows:

Time in seconds	25 or less	26–28	29–31	32–34	35–37	38–40
Credits	15	13	11	9	7	5
Total possible score (two trials)						30

119. Step III—Relaying the Mortar for Changes in Firing Data

a. Equipment.

(1) *For candidate.* Complete mortar with sight, one aiming post, and firing table.

(2) *For testing officer.* Stopwatch and DA Form 3214–R.

b. Conditions.

(1) The mortar is mounted as described in paragraph 13 with a base post placed approximately 25 meters from the mortar position. The mortar is laid on the post with a deflection of less than 75 mils set off on the sight and the traversing mechanism (bearing) approximately centered. The elevation scale is set at 62° and the longitudinal and cross-level bubbles are centered.

(2) For each trial, the candidate takes the gunner's position on the left of the mortar and checks to see that it is mounted correctly and laid as described. If the candidate desires, he may start this test with his left hand on the deflection knob of the sight.

(3) The amount of deflection given does not exceed 60 mils and the range given does not require an elevation less than 57° or greater than 67°.

(4) Each candidate is given two trials.

c. Procedure.

(1) When the candidate is ready to receive the command, a subsequent command is announced by the testing officer. For example: LEFT FOUR ZERO, EIGHT HUNDRED.

(2) The candidate repeats each element of the fire command, sets the sight with the correct deflection (announced deflection added algebraically to the previous deflection setting), looks up the elevation and charge for 800 meters announces the correct charge, lays the mortar for elevation, and relays on the left edge of the aiming post, cross-leveling simultaneously. As soon as the mortar is laid, the candidate commands: FIRE.

(3) Time is taken from RANGE in the fire command to the command FIRE by the candidate.

d. Scoring.

(1) No credit is given if the—

(*a*) Time exceeds 40 seconds.

(*b*) Announced charge is incorrect or omitted.

(*c*) Sight is set incorrectly for elevation or deflection.

(*d*) Mortar is not correctly laid for elevation.

(*e*) Mortar is not cross-leveled.

(*f*) Vertical line of the collimator is more than 5 mils off the left edge of the aiming post.

(2) When the mortar is found to be laid correctly within the limits prescribed, credit is given as follows:

Time in seconds	25 or less	26–28	29–31	32–34	35–37	38–40
Credits	15	13	11	9	7	5
Total possible score (two trials)						30

120. Step IV—Marking Base Deflection

a. Equipment.

(1) *For candidate.* Complete mortar with sight and three aiming posts.

(2) *For testing officer.* Stopwatch and DA Form 3214–R.

b. Conditions.

(1) The mortar is mounted as described in paragraph 13 with the base post placed approximately 25 meters from the mortar position. A deflection (not less than 40 mils or more than 60 mils) is set off on the sight and the mortar is relaid on the base post by traversing. The elevation scale is set at 62° and the longitudinal and cross-level bubbles are centered. The conditions set forth are checked by the candidate before his first trial.

(2) The candidate is allowed one assistant to place out aiming posts.

(3) Each candidate is given two trials.

c. Procedure.

(1) When the candidate is ready, a member of the board issues the following command: MARK BASE DEFLECTION, PLACE OUT TWO ADDITIONAL AIMING POSTS.

(2) The candidate repeats the command, sets the sight with a deflection of zero, and without changing the lay of the mortar directs his assistant in realining the base post. The assistant cannot move out from the vicinity of the mortar until the announcement of the first element of the command. He realines the base post by moving it in line with the white line of the collimator as directed by the candidate. The candidate then centers the traversing bearing and relays the mortar on the base post with zero mils deflection by moving the bipod legs. As soon as the mortar is relaid on the base post the candidate places left and right 150 mils on the sight and directs the assistant in placing out the first right and left posts. He then resets the deflection scale at zero and announces UP.

(3) Time is taken from the first word, MARK, of the command to the announcement UP by the candidate.

d. Scoring.

(1) No credit is given if—

(*a*) Time exceeds 75 seconds.

(*b*) Traversing handwheel is turned before the base post is realined.

(*c*) Sight is set incorrectly for deflection.

(*d*) Mortar is not cross-leveled.

(*e*) Angle between the base post and the additional aiming posts is in error more than 5 mils.

(*f*) Vertical line of the collimator is more than 5 mils off the left edge of the aiming post.

(*g*) The traversing bearing is more than two turns off center.

(2) When the mortar is found to be laid correctly within the limits prescribed, credit is given as follows:

Time in seconds	60 or less	61–63	64–66	67–69	70–72	73–75
Credits	15	13	11	9	7	5

Total possible score (two trials) ------- 30 points

121. Step V—Laying Mortar on Additional Aiming Stake

a. Equipment.

(1) *For candidate.* Complete mortar with sight, three aiming posts, and firing table.

(2) *For testing officer.* Stopwatch and DA Form 3214–R scorecards.

b. Conditions.

(1) Three aiming posts are set out approximately 25 meters from the mortar in such position that the angular distance between the center post and each of the flank posts measured at the mortar position is 150 mils. The posts are designated as base post, first left post, and first right post.

(2) The mortar is mounted with the elevation scale set at 62°, and the longitudinal and cross-level bubbles are centered. The deflection scale is set at zero and the traversing mechanism (bearing) is approximately centered. The mortar is laid initially on the base post and checked by the candidate before each trial is begun.

(3) The amount of deflection given does not exceed 60 mils and the range given does not require an elevation less than 57° or greater than 67°.

(4) Each candidate is given two trials.

c. Procedure.

(1) The candidate in the gunner's position on the left of the mortar may place his left hand on the deflection knob of the sight if he so desires. The testing officer gives the fire command for laying the mortar on either of the other two posts. For example: NUMBER ONE, HE, ONE ROUND, LEFT TWO FIVE, FIRST RIGHT POST, SEVEN FIVE ZERO.

(2) The candidate repeats each element of the fire command, sets the sight with the given deflection, looks up the elevation and charge for 750 meters, announces the correct charge, sets the sight with the elevation, moves the bipod legs, lays the mortar for elevation, and relays on the left edge of the designated aiming post with the announced deflection and with the elevation corresponding to the announced range. As soon as the mortar is laid, the candidate commands: FIRE.

(3) Time is taken from the announcement of the range in the fire command, to the command FIRE by the candidate.

(4) For the second trial, the mortar is relaid on the base post. A different deflection, range, and aiming post are given.

d. Scoring.

(1) No credit is given if the—

(*a*) Time exceeds 50 seconds.

(*b*) Sight is set incorrectly for elevation or deflection.

(*c*) Announced charge is incorrect or omitted.

(*d*) Mortar is not correctly laid for elevation.

(*e*) Mortar is not cross-leveled.

(*f*) Vertical line of the collimator is more than 5 mils off the left edge of the proper aiming post.

(*g*) Traversing mechanism (bearing) is more than two turns off the center position.

(2) When the mortar is found to be laid correctly within the limits prescribed, credit is given as follows:

Time in seconds	35 or less	36–38	39–41	42–44	45–47	48–50
Credits	15	13	11	9	7	5

Total possible score (two trials) .... 30 points

122. Step VI—Manipulation of the Mortar for Traversing Fire

a. Equipment.

(1) *For candidate.* Complete mortar with sight, one aiming post, and firing table.

(2) *For testing officer.* Stopwatch and DA Form 3214–R.

b. Conditions.

(1) The mortar is mounted as prescribed in paragraph 13 with a base stake set out approximately 25 meters from the mortar. The mortar is laid on the stake with the deflection scale set at zero and the traversing bearing approximately centered. The elevation scale is set at 62° and the longitudinal and cross-level bubbles are centered.

(2) When the mortar has been laid, the testing officer directs the gunner to PREPARE TO TRAVERSE RIGHT (LEFT). The candidate then moves the traversing mechanism so that the bearing is positioned all the way to the right (or left). He then traverses back two turns to allow for laying the mortar exactly on the aiming post. He does not relay on the aiming post until the fire command is issued.

(3) The number of cartridges specified in the fire command is always four.

(4) The amount of traverse between cartridges fire is either two or three turns.

(5) The range given does not require an elevation of less than 57° or greater than 67°.

(6) Each candidate is given two trials.

c. Procedure.

(1) When the candidate is ready, a fire command is announced by the testing officer. For example: FOUR ROUNDS, TRAVERSE RIGHT THREE TURNS, NINE HUNDRED.

(2) The candidate repeats each element of the fire command, looks up the elevation and charge for the announced range, announces the correct charge, sets the elevation on the sight, checks the deflection scale on the sight to make sure it is set at zero, moves the bipod legs, lays the mortar for elevation, relays on the left edge of the aiming post, commands FIRE ONE; traverses the required number of turns, cross-leveling at the same time, commands FIRE THREE; traverses and cross-levels, and commands FIRE FOUR.

(3) Time is taken from RANGE in the fire command to the command FIRE FOUR by the candidate.

d. Scoring.

(1) No credit is given if the—

(*a*) Time exceeds 80 seconds.

(*b*) Announced charge is incorrect or omitted.

(*c*) Candidate fails to command FIRE for each cartridge.

(*d*) Sight is set incorrectly for elevation.

(*e*) The candidate makes no attempt to cross-level before firing each cartridge.

(*f*) Mortar is not cross-leveled after firing the last cartridge.

(*g*) Vertical line of the collimator is more than 20 mils off the left edge of the aiming post after the mortar has been traversed and cross-leveled in the opposite direction (by the testing officer) the total number of turns required by the fire command. The total number of turns is equal to the number of cartridges fired less one, times the number of turns between cartridges as specified in the fire command. For example, in the above sample fire command issued by the testing officer, the candidate is required to traverse right a total of nine turns. To check the manipulation, the mortar is traversed nine turns to the left, cross-leveled, and checked to see that the vertical line of the collimator is within 20 mils (right or left) of the left edge of the aiming post.

(2) When the mission has been fired correctly within the limits prescribed, credit is given as follows:

Error in mils	10 or less	11–20
Credits:		
Time in seconds 50 or less	20	16
Time between 51 and 65 seconds	16	12
Time between 66 and 80 seconds	12	8
Total possible score (two trials)	-----	40

CHAPTER 7

ELEMENTS OF INDIRECT FIRE

Section I. GENERAL

123. Emplacement of Mortars

a. In the attack, the mortar section is normally employed as a squad, fired as a squad, and supplied as a squad. However, section employment can and should be used whenever possible. The mortars are placed in firing position in proximity to the platoon to which they are attached. Positions are selected with regard to communication between mortars, cover, concealment, and defilade. When emplaced in a section firing position, the mortars are separated approximately 30 meters laterally unless the terrain and the situation dictate otherwise. Less dispersion increases the danger from enemy mortars or artillery; greater separation necessitates closing the sheaf to obtain the same volume of fire and complicates control and ammunition supply. Normally, the mortars are laid on the same azimuth so that the fire of any one or all mortars can be placed on a single target. When possible, they are placed on line so that the same elevation can be placed on all mortars when engaging a target.

b. The section may or may not be employed as a unit in the defense. It may be emplaced as a unit, or it may be emplaced with the squads widely separated. When emplaced as a unit, the squads may all have the same sector of fire or each squad may have a different sector of fire. In either case, however, the fire is controlled by the FDC. When the squads are widely separated, the squad computer controls the fire.

124. Communications

a. General.

(1) Communication between the forward observers and the FDC is by radio, wire, messenger, and prearranged signals. Communication between the FDC and the mortar positions is by voice or by telephone.

(2) The FO parties take telephones and radios with them as they go forward. A switchboard is set up at or near the FDC. When the distance between the FDC and the firing position is such that voice communication is impossible, wire lines are laid to the mortar positions. When all mortars are in one position, one wire line is laid to the position. When the section is widely dispersed in one position, one or more telephones may be placed on a party line. When the mortars are located in one position under section control and are firing by squad, a separate line is laid to each squad position. When the mortars are located by squad but still under section control, a separate line is laid from the switchboard to each squad firing position.

(3) As a second means of communication, the observers and the FDC are equipped with voice radios operating on the same frequency.

b. Numbers. When numbers are given as part of a message or command, whether by voice, by telephone, or by radio, exact hundreds and thousands are so announced; in other numbers, each digit is given separately. The decimal point is stated as POINT.

Example

Numbers	*Numbers as stated*
5.5	FIVE POINT FIVE
10	ONE ZERO
25	TWO FIVE
300	THREE HUNDRED
1,400	ONE FOUR HUNDRED
2,925	TWO NINE TWO FIVE
4,000	FOUR THOUSAND

Note. Fire commands in subsequent paragraphs show arabic numerals, but in each case they are to be stated as above.

125. Factors Affecting Trajectories of Mortar Cartridges

a. The trajectory is the path followed by the mortar cartridge in its flight to the point of impact or burst.

b. An understanding of the forces that act on a projectile enables a mortar crew to minimize the adverse forces and obtain more effective fire on a target. A great number of conditions affect mortar fire, and the possibility of obtaining identical trajectories in firing is improbable; that is, if a number of cartridges are fired at the same elevation and deflection, all of them will not fall on the same point. Some of the conditions affecting the motion of the projectile which can be partially controlled by the mortar crew are listed below.

(1) *Muzzle velocity.* Differences in muzzle velocity may be caused by variations in the weights of the projectiles, amounts of propellant, rate of burning of the propellant, and variations in the space between the cartridge and the inner surface of the bore. There is little that a mortar crew can do to equalize further the weights of cartridges other than to use the same type and lot number during any single adjustment and fire for effect. The crew can help standardize the muzzle velocity by being very careful that the correct number of powder increments are firmly attached to the cartridge when it is fired and that they are kept dry prior to firing. The amount of friction between the projectile and the bore is kept approximately constant by making sure that each projectile is free of burrs, sand, or other foreign matter; and by keeping the bore free of powder fouling. Each cartridge is carefully inspected before firing. The bore of the mortar is swabbed clean after every 10 cartridges, or after firing for effect.

(2) *Elevation and direction.* Some of the conditions which affect the elevation and direction of the barrel are play in the mechanism of the mount, degree of accuracy of the sight, settling of the baseplate while the first few cartridges are being fired, and the accuracy with which the gunner lays and relays the mortar. The gunner can minimize errors caused by these factors by accurately laying the mortar between each cartridge, by choosing a level, firm spot for the baseplate, and by requiring the loader to load the piece without applying any pressure on the barrel of the mortar. Correct maintenance and care of the mount and sight reduce to a minimum the introduction of mechanical play or inaccuracy.

(3) *Forces on projectile during flight.* Projectiles are affected by air density, temperature, and irregular movements of the air in the form of head, tail, cross, or oblique winds. The mortar crew can do nothing to correct for changes in air density or temperature, but it can do something to eliminate unfavorable effects of the wind.

Section II. TARGETS

126. General

a. Mortar targets must be carefully selected. When direct fire weapons can accomplish the job, mortar fire should not be used.

b. Ammunition resupply is an important factor in mortar fire. A rifle bullet weighs only a few ounces, while a mortar round weighs several pounds. Do not use a mortar cartridge when a rifle bullet will do the job. But do not hesitate to call for mortar fire when it is needed. As a guide, the following is a partial list of appropriate mortar targets:

(1) Troops in the open or dug in.
(2) Machineguns.
(3) Heavy weapons such as mortars or artillery.
(4) Assembly areas.
(5) Truck columns and parks.
(6) Tanks accompanied by infantry.
(7) Supply or ammunition dumps.
(8) Reverse slopes and defiladed areas behind buildings or embankments.
(9) Observation points.
(10) Areas to be smoked to deny hostile observation.

(11) Areas to be illuminated during hours of darkness.

127. Sources of Targets

Targets may be located and reported by organic observers by supported troops, by mortar liaison personnel with those troops, by field artillery ground or air observers, by higher headquarters (from air and ground reconnaissance agencies), by analysis of photos and knowledge of enemy activity, and through interrogation of prisoners of war and civilians. The search for targets must be vigorous and continuous.

128. Attack

a. Mortar fire must conform to the scheme of maneuver of the supported unit. Once action is started, the section maneuvers its fire to continue the support in accordance with reports of liaison personnel and forward observers.

b. When the location of a target and the time of attacking it are known, the commander must, within the time available, consider the following pertinent points:

(1) Nature of the target (type, mobility, cover, importance).
(2) Results desired.
(3) Registration and survey control available.
(4) Area to be attacked.
(5) Rate of fire.
(6) Amount of ammunition available.
(7) Units to give desired coverage.
(8) Technique of attack.

c. To determine the proper type of cartridge and necessary ammunition expenditure, the nature of the target is carefully considered. The target itself is a guiding factor in determining the size of bracket sought, the type of adjustment, and the speed of attack. A study of enemy methods and equipment will also assist in the selection of the best method of attacking the target.

d. The method of attacking a target is influenced by the results desired from the fire. In general, these results are of four types.

(1) *Destruction.* Fire delivered to destroy material objects. Usually a great amount of ammunition and time are required. Observation is essential.

(2) *Neutralization.* Fire of great intensity on a target with the object of causing severe losses, preventing movement or action, causing limited destruction of materiel, and in general, destroying the combat efficiency of the enemy.

(3) *Harassing.* Fire of less intensity than neutralization, designed to inflict losses or, by the threat of losses, to disturb the enemy troops, to curtail movement, and to lower morale.

(4) *Interdiction.* Fire, usually of less intensity than neutralization, laid down on lines of communication to disrupt or intermittently deny their use to the enemy.

e. With adequate registration or survey data, the mortar can deliver effective unobserved fire.

f. The area to be attacked may be determined by the actual size of the target or by the area in which the target is known to be.

g. Surprise fire delivered with maximum density creates the greatest demoralization and destruction. In the event the section is employed in separate positions, allowances are made for time of flight. This causes all the cartridges to strike the target simultaneously (time-on-target method). In such cases, because of the limits to the rate of fire (maximum rate of 30 cartridges the first minute and 18 cartridges per minute for sustained fire) density is best secured by massing the fires of all mortars on appropriate targets. Offsetting the great initial effect of surprise massed fires is the fact that the number of weapons may give a beaten zone larger than the target and therefore waste ammunition. Effective massed fires cannot be sustained without extravagant ammunition expenditure. These factors may require the use of one mortar even though the entire section can be massed.

h. The amount of ammunition available is the first consideration in the attack. The available supply rate of cartridges per mortar per day may not be exceeded except by authority of higher headquarters. When the available supply rate is as small as 10 to 20 cartridges per mortar per day, missions should be limited to those which can be observed and which immediately affect friendly troops and operations. When the available supply rate is larger (20 to 100 cartridges per mortar per day) missions may include those which affect planned or future operations, as well as those which will require some massing of fires without adjustment. For operations against a strong hostile force, as much as 100 to 300 cartridges per mortar per day may be available.

i. If the rectangle of dispersion of the unit to fire is larger than the target area, ammunition may be wasted. On the other hand, if the unit can cover only a small part of the target area at a time, surprise is lost during the shifting of fire, and the rate of fire for the area as a whole may be insufficient to obtain the desired effect.

j. When the area covered is too large to be covered by a single target, it is attacked in parts. If a section is available for each part and its fire is deemed sufficiently dense, the entire area may be attacked at one time. Otherwise, the parts are attacked successively by the section.

k. Normally, the section is located in one firing position with the fire of the entire section under the control of the FDC (ch 11). Whether to have one or two mortars fire a few volleys, or the section fire many volleys, is often a critical decision. The factors affecting this decision vary with every situation and are listed below.

(1) *Availability of mortars.* When the mortars cannot cover the same sector of fire or a large part of the same sector of fire, each mortar will have to attack a larger number of targets alone.

(2) *Size of area to be covered.* Two mortars employed on a target cover a larger area than a single mortar, no matter how carefully corrections are applied. The attack of a small target with the fire of the section increases density of fire on the target. This fire density, however, does not increase as rapidly as the expenditure of ammunition. It increases the certainty of some effect by covering an area larger than the target area.

(3) *Surprise.* Against certain targets, short bursts from many pieces are preferable to sustained fire from a few pieces. To secure surprise, the method of attack must be constantly varied.

(4) *Accuracy of target location.* Certain important targets are so indefinite as to size and location as to justify the fire of of the entire section to insure coverage.

(5) *Critical targets.* The emergency nature of certain targets (such as enemy counterattack formations) may justify the use of all available mortar fire without regard to economy of ammunition.

(6) *Dispersion.* Coverage at long ranges is less dense and requires more ammunition. If the section is employed in separate firing positions, firing at long ranges may require the selection of the mortar which can most nearly fire along the long axis of the target to obtain the maximum effect from dispersion.

(7) *Maintenance of neutralization, interdiction, and harassing fires.* This may require the use of one squad to leave the remainder of the section free for other missions.

(8) *Vulnerability of targets.* Some targets, like truck parks, should be attacked with massed fire to insure immediate effect and to release the mortars for other missions.

(9) *Available ammunition.*

(10) *Effect on enemy personnel.* A strong demoralizing effect can be achieved by smothering a hostile position with fire.

l. Large targets offer a wide choice in methods of distributing the fire of units selected to fire on them. Great care must be exercised in firing on area targets close to supported troops.

m. The technique of attack is determined by a careful analysis of the capabilities of the weapons and ammunition available, the terrain of the target area, and the most effective method of attacking the target. Within the limitations of the fuze, time fire may be used most effectively against personnel.

129. Typical Targets and Methods of Attack

a. Tanks and Combat Vehicles in Assembly Area, Rendezvous, or Park. The area may be attacked with any or all available weapons, using either observed or unobserved fires, for the purpose of neutralization. HE cartridges fired with a quick fuze are effective.

b. Tanks and Combat Vehicles in Attack. Tanks usually advance by bounds, using available defilade and keeping dispersed. Tank attacks frequently can be broken up by concentrations of HE cartridges if the mortar fire is violent and all available weapons are used. Tanks in the approach march will be forced to button up with very light fire using HE cartridges. Caution should be used in firing WP as it may obscure the tanks and prevent adjustment of fire. WP may also prevent effective fire by direct fire weapons.

c. Mortars, Light Artillery.

(1) When these weapons are in position, in hasty emplacements, or under light cover and are firing, the mortar objective us-

ually is to neutralize them. If the weapons can be seen, destruction fire is used.

(2) Weapons having an unusual degree of mobility, such as certain rocket guns, often are brought from concealment and fired in the open. The crews load, fire, and rapidly move to new positions. Surprise fire (with registration corrections applied) and speedy bracketing adjustment, using HE cartridges with a quick fuze, is appropriate against these weapons.

(3) Light weapons are not considered separately as their neutralization is effected by neutralization of personnel. Their mobility is such that precision methods against them usually are not practicable, and a certain amount of destruction is incidental to fire for neutralization.

d. Vehicles Such as Trucks, Prime Movers, and Personnel Carriers.

(1) Vehicles in bivouac or a park may be attacked as an area target by observed and unobserved fire. HE cartridges with quick fuzes are appropriate. If combustible material can be ignited, WP is effective.

(2) When vehicles are moving along a road, observed fire must be used. The objectives are twofold— to stop the column; and to destroy the material. A deep bracket is sought initially. When the road can be identified on the firing chart, a section or several sections may fire simultaneously, the fire of the sections being fitted to the road. Columns of widely spaced units have been attacked successfully by first registering on a defiinite point (usually a point at which vehicles cannot leave the road, as at a defilade or culvert), then timing volleys to reach that point simultaneously with each vehicle. The HE cartridge with a quick fuze is very effective when a hit or near hit is obtained.

(3) Landing craft may be attacked with any or all available weapons.

e. Personnel.

(1) *In open.* Personnel in the open usually are dispersed and able to take advantage of available cover and concealment. Personnel forced to abandon their activity and seek cover are neutralized. In neutralization, surprise is not an essential factor. Effective fragmentation is required against seasoned troops to produce neutralization. HE cartridges with a quick fuze are effective. Repeated short bursts of fire at irregular intervals have a cumulative effect and are far more effective than the same amount of ammunition expended in one long target. If the object is to produce casualties, surprise is essential. It is obtained by the use of accurate data, surveillance, and massed sections delivering time-on-target (TOT) fire.

(2) *In trenches or foxholes.* Personnel in trenches, lightly constructed emplacements, or foxholes usually are dispersed, concealed, relatively immobile, and protected against all but vertically descending fragments. Surprise usually is not essential. The superquick fuze on the HE cartridge is most effective. In order to produce casualties, many cartridges are required; hence, either many weapons or many cartridges per weapon must be used. WP is effective in driving personnel out of foxholes into the open where HE cartridges can be used more effectively.

(3) *With light overhead cover.* Impact bursts crush light overhead cover. Some neutralization and casualty effects result from any suitable method of attack.

f. Buildings. Buildings of frame and other light construction are attacked with the HE cartridge with a quick fuze or with a WP cartridge (for incendiary effect).

g. Defensive Works: Bunkers. For bunkers of composite construction, such as earth and logs, sand-filled oil drums, and sand bags, the HE cartridge with a superquick fuze is required. Several direct hits generally are necessary.

h. Supply Installations. Harassing or neutralizing fires (the distinction depending principally on the amount of fire) are employed. They consist of observed or unobserved fires with ammunition suitable for use against personnel in the open. The object is to hamper operations at the installation. Some destruction usually results. If destruc-

tion is sought, HE cartridges and quick fuzes are used.

i. Bridges and Lines of Communication. Where it is desired to effect interdiction without extensive damage to or destruction of lines of communication and associated material, as when intact capture and subsequent use of these facilities by friendly troops is contemplated, the HE cartridge with a superquick fuze is extremely effective. Excessive damage to bridges, railroads, and material is avoided both in registration bursts and mortar targets; and at the same time, the use of these facilities is denied enemy personnel.

130. Fire for Effect

Fire for effect is started when a satisfactory adjustment has been obtained. Fire for effect is delivered by firing a number of cartridges as rapidly as accuracy in laying the mortar permits. The FDC determines the number of rounds to be fired. This fire is based on the size and nature of the target and available ammunition. When an FDC is not used, the observer determines the number of cartridges. Upon completion of the fire for effect, the observer terminates the mission and reports observed results.

CHAPTER 8

TECHNIQUE OF FIRE WITHOUT A FIRE DIRECTION CENTER

Section I. GENERAL

131. Introduction

a. This chapter gives the procedures and techniques for conduct of squad and section fire. The normal employment of 60-mm mortars is by individual squads controlled directly by the squad leaders. The squad leader observes the target area from an observation post (OP) and controls the fire by issuing fire commands directly to the mortar crews.

b. Throughout this chapter, the M4 sight is used with the mortar. If the M34A2 or M53 sight is to be used, see FM 23-90 or FM 23-92.

132. Mil Relation

a. Definitions. For computing firing data, the unit of length or distance is the *meter*, while the unit of angular measure is the *mil* (m). One mil is equal to 1/6400 of a circle. Therefore, since 360° equal 6400 mils, 1° equals approximately 17.8 mils. For practical use a mil may be defined as the angle which subtends a width of approximately one unit at a distance of 1,000 units. In other words, a mil is an angle that is approximately 1 meter wide at a distance of 1,000 meters, or 3 meters wide at a distance of 3,000 meters (fig. 42). For angles less than 400 mils, the mil relation is accurate enough for use in computing firing data.

b. Use of the Mil Formula.

(1) The mil relation may be expressed in the mil formula, $W/RM=1$. This formula is easy to remember as the WORM formula, W Over RM:

W represents width in meters.

M represents angular measure in mils.

R represents the range or distance in thousands of meters.

(2) *Example* (fig. 43). An observer desires to know the distance between two objects (A and B). He estimates the range to be 1,200 meters, and with his binoculars he reads the angle AOB to be 40 mils.

$R=1200/1000=1.2$ (thousands of meters);

$M=40$ m; W=? Substituting in the formula $W/RM=1$ (or $W=RM$)

$W=1.2\times40=48$ meters.

Any one of the three elements of the formula may be determined when the other two are known (fig. 43).

c. Use of Deflection Conversion Table (table I). It is often necessary in preparing and conducting fire to convert, at various distances, meters of deflection to mils or mils to meters. Table I may be used for this purpose.

(1) *Example 1.* To determine the equivalent in mils for 100 meters at a distance of 1,200 meters, read horizontally on the line marked 1,200 to the column headed 100. The number of mils is 85.

(2) *Example 2.* To determine the equivalent in meters for 95 mils at a distance of 800 meters, read horizontally on the line marked 800 until 95 mils is found. Then look up that column to determine the number of meters which is 75.

(3) *Example 3.* To determine the equivalent in meters for 65 mils at a distance of 700 meters it is necessary to interpolate. Reading in the 700-meter line, note that there is no 65 mil number. It falls about halfway between the numbers 58 and 73. At a distance of 700 meters, 58 mils equal 40 meters and 73 mils equal 50 meters. As 65 is approximately halfway between 58 and 73, at 700 meters 65 mils equal 45 meters.

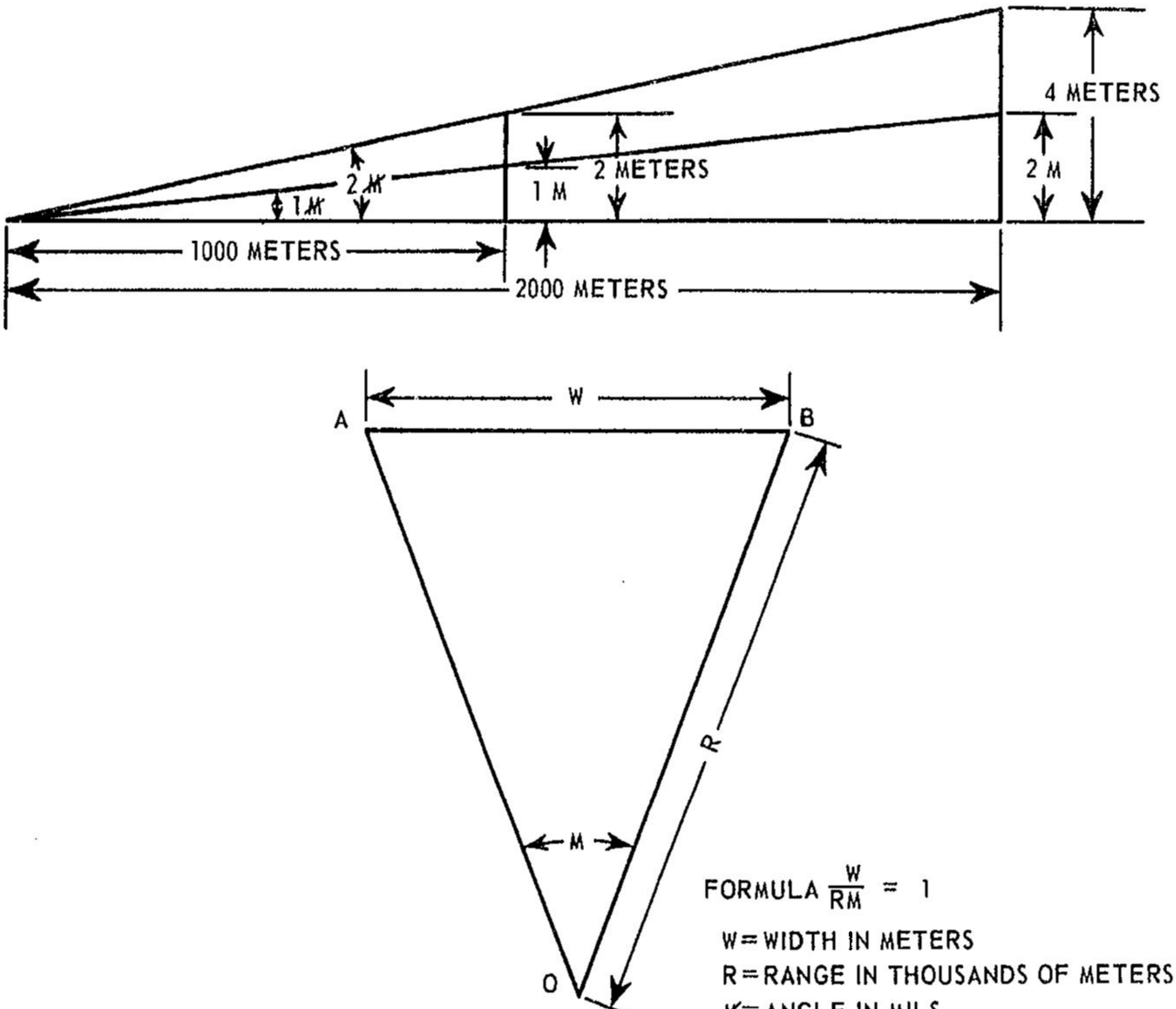
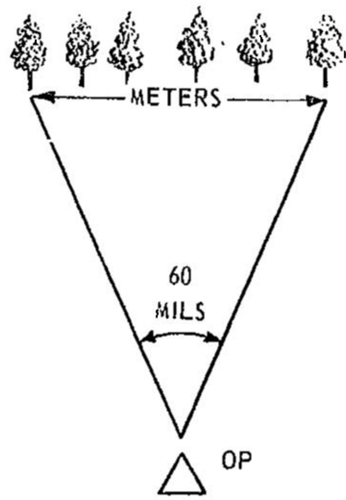


Figure 42. Mil relation.



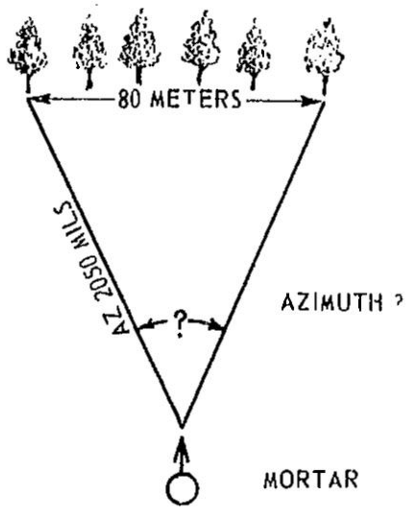
THE TARGET AREA IS MEASURED TO BE 60 MILS IN WIDTH AT A DISTANCE OF 1500 METERS, WHAT IS THE WIDTH OF THE TARGET IN METERS?

$M = 60$ MILS: $R = \frac{1500}{1000} = 1.5$: $W = ?$

SUBSTITUTE IN FORMULA $\frac{W}{RM} = 1$

$W = RM = 1.5 \times 60 = 90$ METERS

(1)



A TARGET HAS A KNOWN WIDTH OF 80 METERS. THE MORTAR POSITION IS 800 METERS FROM THE TARGET. THE AZIMUTH TO THE LEFT EDGE OF THE TARGET IS 2050 MILS. WHAT IS THE AZIMUTH FROM THE MORTAR TO THE RIGHT EDGE OF THE TARGET?

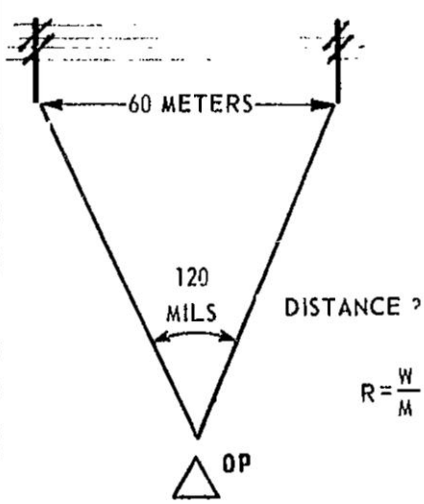
$W = 80$ METERS. $R = \frac{800}{1000} = .8$: $M = ?$

$M = \frac{W}{R} = \frac{80}{.8} = 100$ MILS

2050 MILS PLUS 100 MILS = 2150 MILS

(AZIMUTH TO RIGHT EDGE OF TARGET)

(2)



FROM THE OP A LINE OF TELEPHONE POLES IS OBSERVED IN THE TARGET AREA INTERVAL BETWEEN POLES IS 60 METERS. FROM THE OP THE POLES APPEAR TO BE 120 MILS APART. HOW FAR ARE THE TELEPHONE POLES FROM THE OP?

$W = 60$ METERS. $R = ?$: $M = 120$ MILS

$R = \frac{W}{M} = \frac{60}{120} = .5$ (THOUSANDS OF METERS OR 500 METERS)

(3)

Figure 43. Problems involving the mil formula.

TABLE I. *Deflection Conversion Table*

(Deflection in mils)

Range (meters)	Deflection in meters														
	1	10	20	30	40	50	75	100	125	150	175	200	300	400	500
500	2.0	20	41	61	81	102	152	201	250	297	343	388	550	687	800
600	1.7	17	34	51	68	85	127	168	209	250	289	328	472	599	708
700	1.5	15	29	44	58	73	109	145	180	215	250	284	412	529	632
800	1.3	13	25	38	51	64	95	127	158	189	219	250	365	472	569
900	1.1	11	22	34	45	57	85	113	141	168	195	223	328	426	517
1,000	1.0	10	20	31	41	51	76	102	127	152	176	201	297	388	473
1,100	.93	9	18	28	37	46	69	92	115	138	161	183	271	355	435
1,200	.85	8	17	25	34	42	64	85	106	127	148	168	249	328	402
1,300	.79	8	16	23	31	39	59	78	98	117	136	155	231	304	374
1,400	.73	7	15	22	29	36	55	73	91	109	127	145	215	283	349
1,500	.68	7	14	20	27	34	51	68	85	102	118	135	201	265	328
1,600	.63	6	13	19	25	32	48	64	80	95	111	127	189	250	309
1,700	.60	6	12	18	24	30	45	60	75	90	104	119	178	235	291
1,800	.57	6	11	17	23	28	42	57	71	85	99	113	168	223	276
1,900	.54	5	11	16	21	27	40	54	67	80	94	107	160	211	262
2,000	.51	5	10	15	20	25	38	51	64	76	89	102	152	201	250

Section II. DETERMINATION OF INITIAL DATA

133. General

a. The information needed when determining initial firing data is—

(1) Initial direction of fire.

(2) Initial range.

b. When the squad or section leader is required to prepare initial data, he usually must do so in the shortest time. Consequently, he uses methods that are quick and simple. To provide the necessary data with minimum delay, the vantage point is selected so the observer can see both the target and the mortar position whenever possible.

c. To protect the mortar crew, the mortar is normally located in defilade From this location, the gunner can neither see the target nor lay the vertical line of the collimator directly on the target. Therefore, it becomes necessary to establish an aiming point on which to lay the mortar to engage the target. This aiming point may be an aiming post or some clearly defined object, such as the trunk of a tree or the corner of a building. The method selected to establish this aiming point depends on whether the leader who is determining the initial direction is on the mortar-target line or off to one side of this line. Several methods of determining initial direction of fire are described in the following paragraphs with the choice of method left to the leader determining the initial direction. This method applies to one mortar. When additional mortars are to be laid in the same direction (parallel), the same method is applied to each mortar.

134. Direct Alinement Methods

These methods are applicable only when the leader determining the initial direction is on or near the mortar-target line.

a. Mortar Position Not Fixed. The leader indicates the approximate (base) mortar position, moves forward to a point where he can see the target, places himself on the MORT–TGT line, and drives the M10 aiming post on this line. He turns the alidade until it forms a crosspiece on the aiming stake and tightens the wingnut. He sights along the alidade alining the straightedge

on the target (fig. 44). Without disturbing the position of the alidade, he moves around the aiming post and sights back along the same straightedge to the mortar position and directs that the baseplate stake be driven on this line of sight. The No. 2 man drives the baseplate stake. The gunner mounts the mortar and alines the left edge of the baseplate with the stake-aiming post. When the aiming post is at such a distance or in such a position that it cannot be seen clearly from the mortar

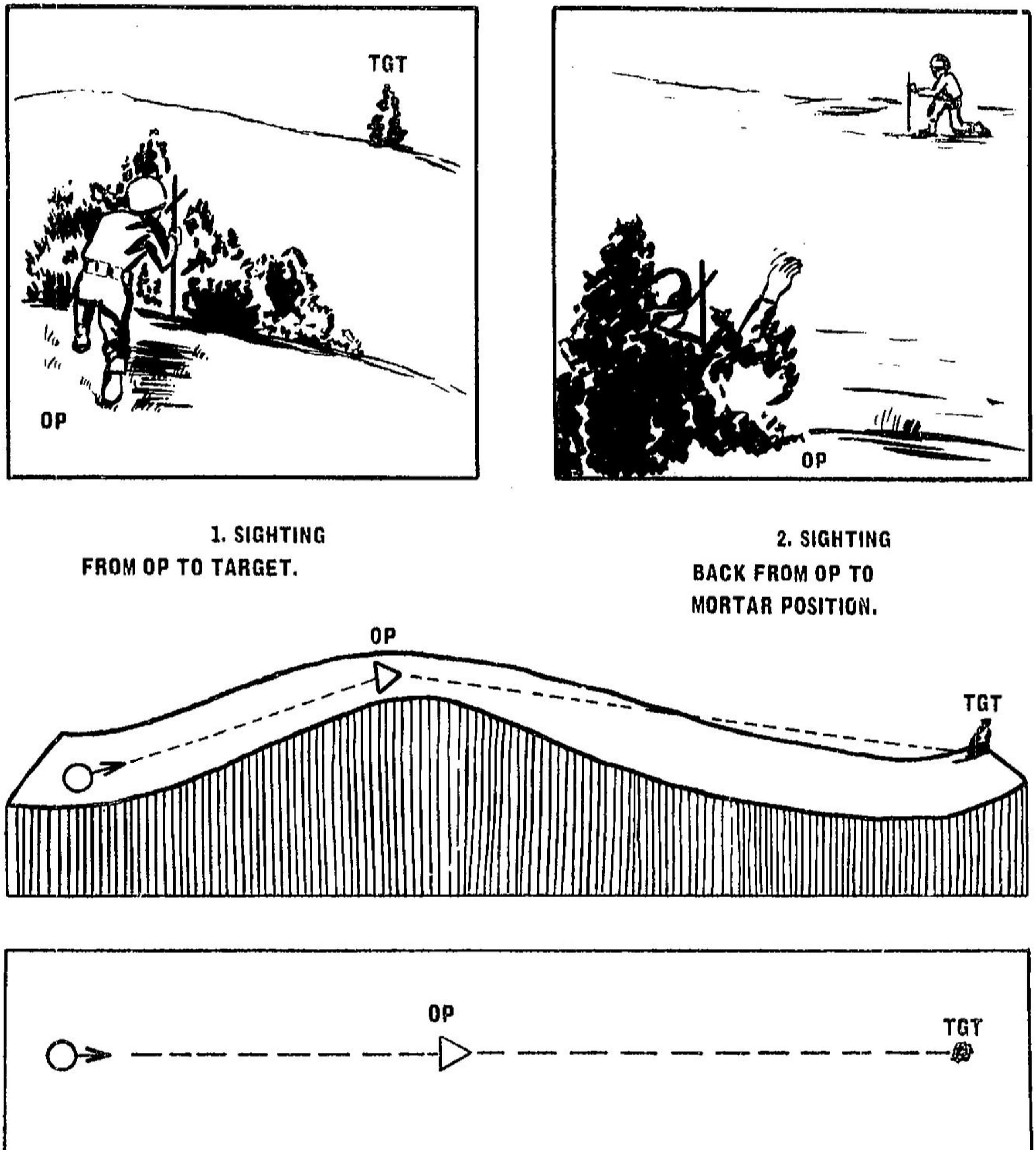


Figure 44. Direct alinement method.

position, No. 2 drives a second stake to be used as an aiming post on the MORT–TGT line about 25 meters from the baseplate stake.

b. Mortar Position Fixed. Where the baseplate has been seated by previous firing or when the terrain limits the mortar position to a definite spot, the leader may establish a new direction of fire by the direct alinement method. He repeats the procedure as in *a* above to include sighting back to the mortar position. If the aiming post is off the MORT–TGT line, he moves it in the required direction and repeats the procedure until the aiming post is on the MORT–TGT line.

c. M10 Aiming Post Not Available. A stake is driven into the ground and any suitable straightedge (stake, a ruler, or a pencil) is placed on it to improvise an alidade.

135. Direct Laying Method

There may be situations where no defilade is available or where speed in destroying a target is more essential than cover. In such a situation, the leader points out the target and directs that the mortar be mounted immediately without aiming posts. Usually such a position is a temporary one and is evacuated as soon as the target is destroyed. When the target is indistinct and the leader has indicated only its direction, he lays the mortar himself as soon as it is mounted. The mortar is laid and fired in the same manner as described for indirect laying except that one clearly defined edge or point of the target is used as the aiming point. When it is apparent that bursts may obscure the target from observation, any suitable aiming point in the target area may be used. Then the leader measures the deviation between the aiming point and the target and includes it in the initial fire command.

136. Azimuth Method

The leader uses this method when he cannot see the mortar position from his vantage point or OP which is on or near the MORT–TGT line. He indicates the mortar position and accompanied by a messenger moves to his vantage point or OP (fig. 45). He places himself approximately on the MORT–TGT line (to help establish this line, he selects a landmark at or near the mortar position before moving to his OP). He reads the magnetic azimuth in mils to the target and then sends the messenger back to the mortar position with the compass and a written notation of the azimuth. The gunner drives a stake to support the compass, lays off the recorded azimuth, and directs No. 2 to place an aiming post on the line of sight of the instrument. (During this operation, the compass is kept at least 10 meters from the mortar and mount to reduce magnetic disturbance.) The compass support stake can then be used as a baseplate stake to aline the baseplate for direction.

137. Range Determination

The squad leader or observer usually estimates the range by eye. However, he may determine the range from a map or aerial photograph. No matter how he first determines the MORT–TGT range, it is usually necessary to determine the exact range to the target by adjustment before firing for effect.

Section III. RANGE ESTIMATION

138. General

The purpose of training in range estimation is to teach the soldier how to estimate ranges by eye with the minimum amount of error. In combat, ranges are usually estimated by eye; therefore, all soldiers should be trained in this method. Stress is placed on estimating ranges between 200 and 1,500 meters. Eye estimation by untrained men is little better than a guess, and the average error of such men is at least 20 percent of the range. A definite system of range estimation frequently practiced is the only way to make estimation by eye reliable.

139. Unit-of-Measure Method

a. Estimation by eye is a method of measuring the range by applying to it a unit of measure 100 meters long. This method is the same as that used in measuring the length of a board with a ruler (fig. 46). The only difference is that the unit of measure is applied mentally. Thorough familiarity with the 100-meter unit and its appearance on different types of terrain and at different distances enables the estimator to apply it with a fair degree of accuracy.

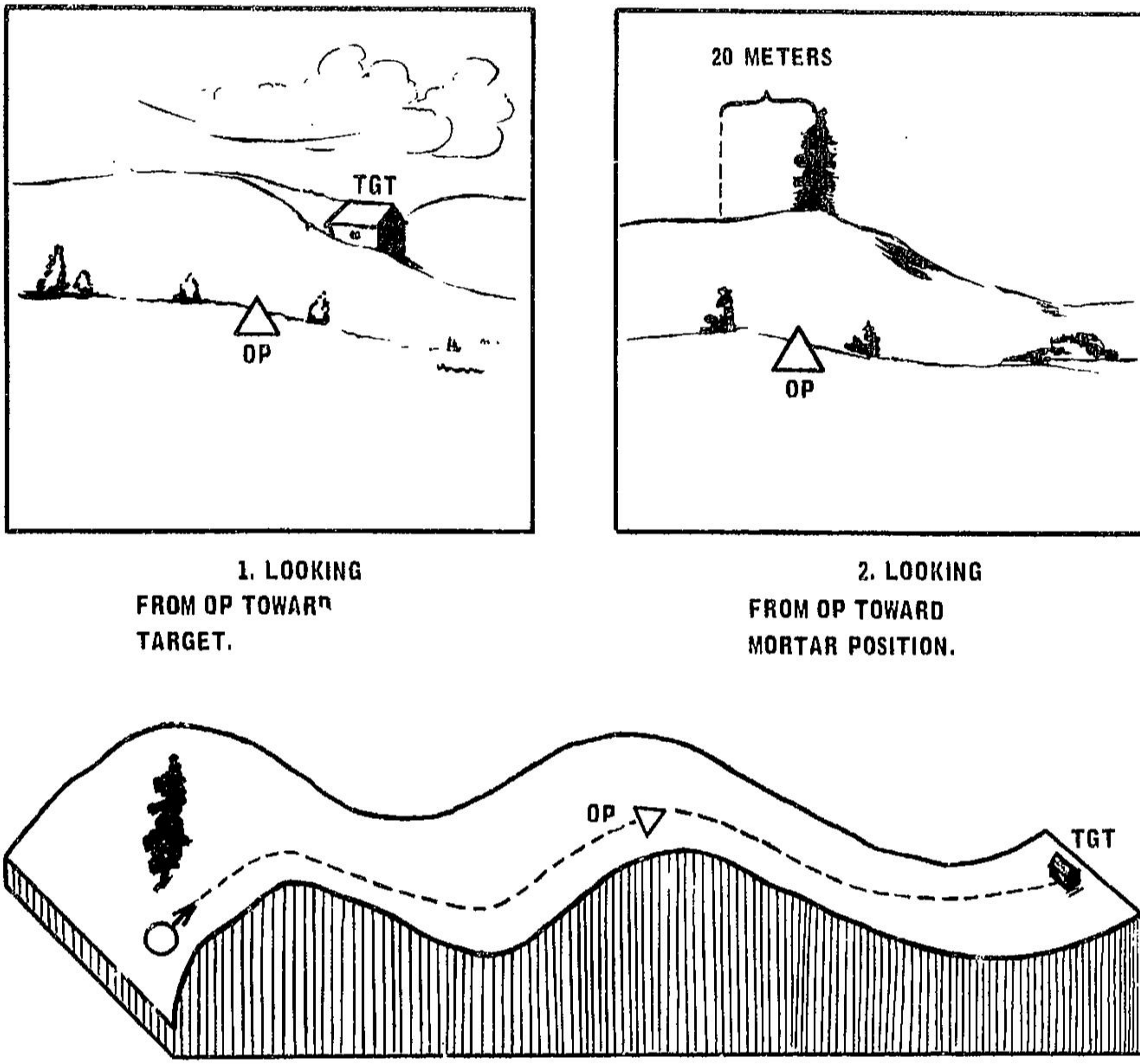


Figure 45. Azimuth method.

b. Application of the unit of measure beyond 500 meters is difficult. To estimate ranges over 500 meters, select a point halfway to the target, apply the 100-meter unit up to this halfway point, and double the result.

c. The average of a number of estimates by different men is generally more accurate than a single estimate. However, in combat the soldier relies on his own estimate.

140. Conditions Affecting the Appearance of Objects

Conditions of light and terrain have considerable effect upon the appearance of objects, making them seem sometimes nearer and at other times more distant than they really are. The effect of these conditions on the appearance of objects within the first 100 meters is negligible.

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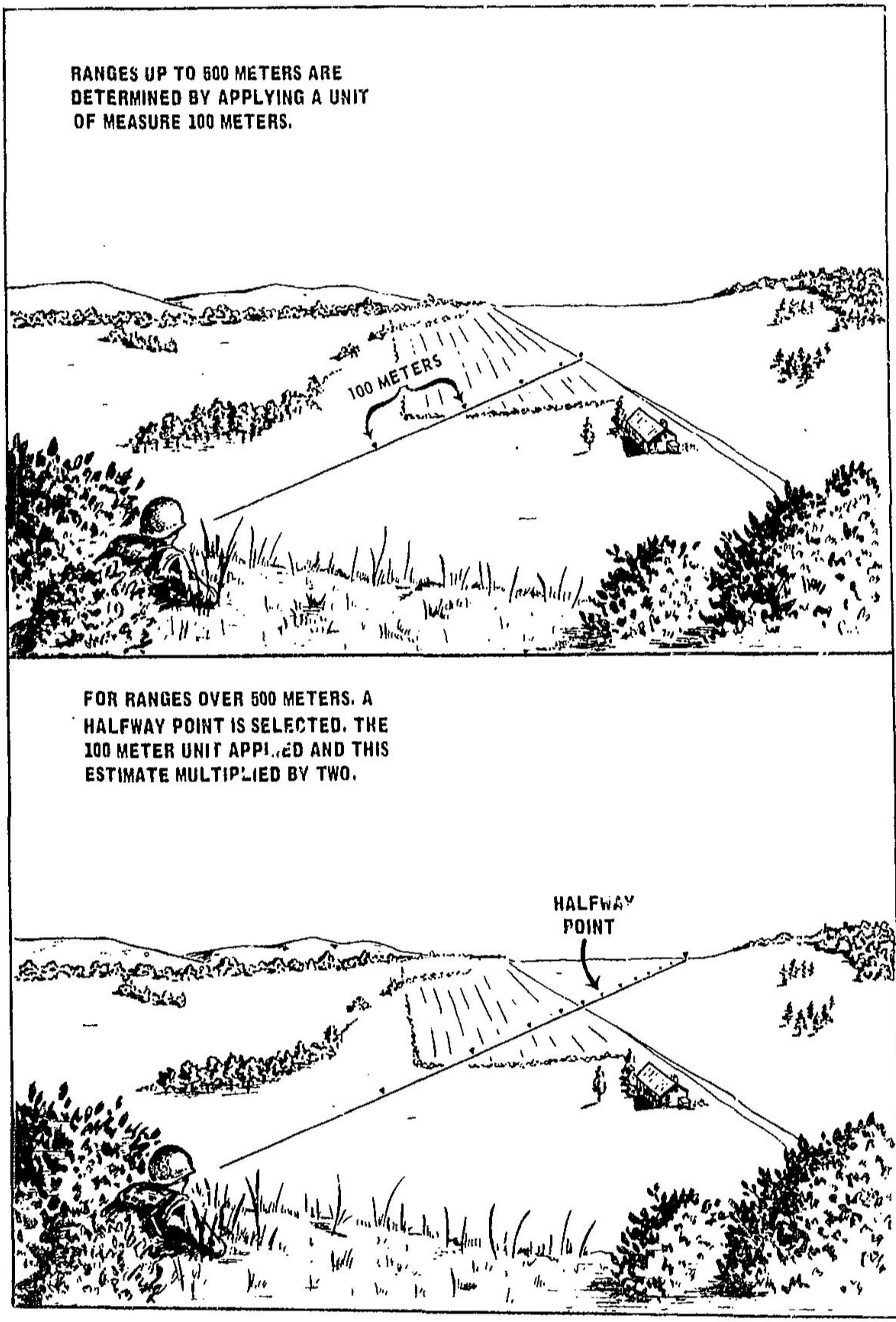


Figure 46. Range estimation by application of the unit of measure.

a. In some cases much of the ground between the observer and the target is hidden from view, and the application of the unit of measure to the hidden portion of the ground is impossible. In such cases the appearance of objects is the only guide. If there is a considerable stretch of visible ground extending from the far edge of the depression to the target, it is best to estimate the distance to the far edge of the depression, judging by the appearance of objects, and then to apply the unit of measure over the remaining distance to the target.

b. Whenever the appearance of objects is used as a basis for range estimation, the observer makes allowance for the existing conditions (fig. 47).

(1) Objects seem nearer when—
  (*a*) The object is in a bright light.
  (*b*) Color of the object contrasts sharply with the color of the background.
  (*c*) Looking over water, snow, or a uniform surface like a wheat field.
  (*d*) Looking from a height downward.

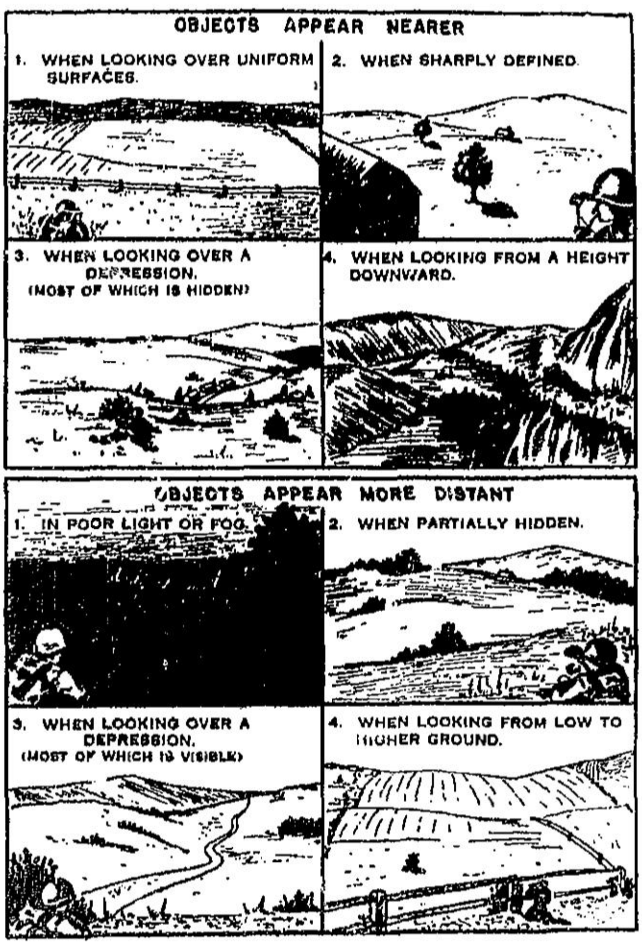


Figure 47. Appearance of ob s in range estimation.

  (*e*) In the clear atmosphere of high altitudes.
  (*f*) Looking over a depression most of which is hidden.
  (*g*) Looking down a straight road or railroad track.

(2) Objects seem more distant when—
  (*a*) Looking over a depression most of which is visible.
  (*b*) There is poor light or fog.
  (*c*) Only a small part of the object can be seen.
  (*d*) Looking from low ground toward higher ground.

141. Exercises in Range Estimation

a. Exercise No. 1 familiarizes the soldier with the 100-meter unit of measure. Stake out the unit of measure (100 meters) on one or more courses over varied ground (fig. 48) with markers that are visible up to 500 meters. Then conduct the men to the 400-meter marker, and form them approximately on a line facing the 500-meter marker. Then have them move back toward the center point until all are on line with the 300-meter marker. Then successively move them to a point on line with the 200-meter marker, 100-meter marker, and the center point. At each of the stopping points, have the men study the appearance of the unit of measure and apply it successively up to the 500-

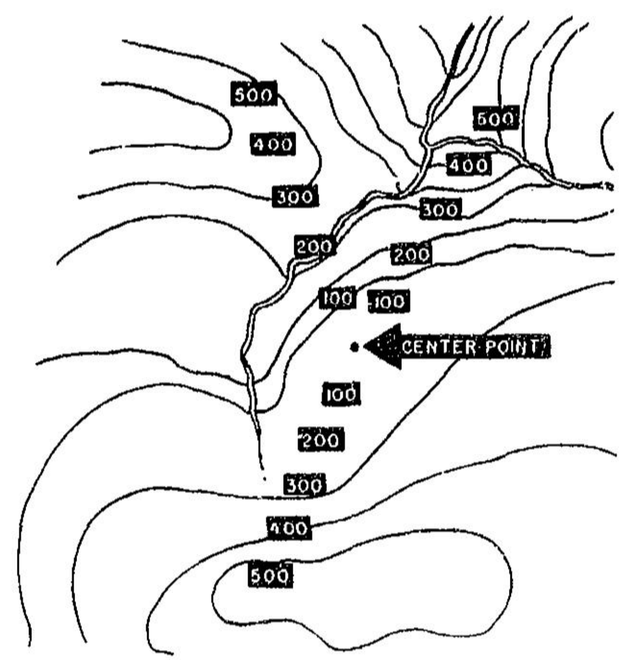


Figure 48. Range estimation layout.

meter marker. Conduct practice of this exercise at each of the several ranges in various positions. Divide the unit receiving instruction into two or more smaller groups, each practicing successively on the several courses. Repeat this exercise until the desired proficiency is attained.

b. Exercise No. 2 illustrates the application of the 100-meter unit of measure. Measure off a range up to 1,000 meters and mark it at every 100 meters by large markers or target frames, each bearing a number to indicate its range. Station a man at each marker to keep it from view until he receives the signal to raise it. Then direct the soldiers undergoing the instruction to apply the 100-meter unit of measure a certain number of times along a straight line in the general direction of the markers. When they have selected the final point reached by mentally applying the unit of measure to the ground the specified number of times, signal the soldiers stationed at the target markers to raise them. Check the estimations of the successive 100-meter points and the final point against the markers. To obtain accuracy repeat the exercise and vary the ranges.

c. Exercise No. 3 gives the soldier practice in range estimation. From a suitable point, measure off ranges to objects within 1,000 meters. Then conduct the group undergoing the instruction to this point. From here, have the men estimate the ranges to the various objects as they are pointed out. Issue them paper for writing down their estimates. Allow 30 seconds for each estimate. When all ranges have been estimated, collect the papers and announce the true ranges to the group. To create interest, post individual estimates and squad averages on bulletin boards accessible to all members of the class.

Section IV. FORWARD OBSERVATION

142. General

This section describes the procedures used by the 60-mm mortar observer for adjusting fire. In order to deliver accurate and effective fire on suitable targets quickly, the observer must be near the firing position. A suitable OP is the dominant factor in selecting a mortar position; hence the OP is selected first. The observer must make continuous efforts to keep the mortar close to and at least within 100 meters of the OP, because then his control of the mortar fire is fastest, most accurate, and easiest. When the observer must move to a new OP to observe his assigned sector, the mortar must be displaced to a position near the OP. When the OP is more than 100 meters from the mortar position, the mortar should be moved closer to the OP. When the terrain or the situation prevents moving the mortar to within 100 meters of the OP, the observer should attempt to place the mortar so that the OP is within 100 meters of the MORT–TGT line. When even this cannot be done, the observer either uses the target-grid method or attempts to visualize the MORT–TGT line and adjust with respect to it (para 146).

143. Spotting

a. General. Spotting is the determination by the observer of the location of a burst or group of bursts with respect to the target. The observer's spotting is a mental process which determines his next correction. When the burst appears, the observer makes his spotting promptly, except when necessary to take advantage of drifting smoke. He bases his spotting on what he sees while the burst is before his eyes, not on what he remembers. When spottings are made on drifting dust, or smoke, the observer considers the wind direction.

b. Range Spotting (fig. 49). A burst which is beyond the target from the observer is spotted *over* for range; one which is between the target and the observer is spotted *short* for range. A round which hits the target is spotted *target*, and one which is at the correct range, but slightly off the OT line, is spotted *range correct*. Range is spotted *doubtful* when no positive spotting is obtained. (When a round is spotted doubtful for range, the observer tries to get a positive spotting by moving the next burst to the OT line; this is done by giving a deflection correction with no change in range.) A *positive spotting* is made from any round which can be definitely located for *both* range and deviation.

c. Deviation Spottings (fig. 49). Rounds are spotted for deviation as *right*, *left*, or *line*. The observer spots all errors in deflection by measuring, in mils, the deviation of each burst from the OT

line. The mil scale in the binocular may be used for this purpose. A burst to the right (left) of the OT line is spotted (so many mils) *right* (left).

Note. When instruments are not available, angles are measured by the hand (fig. 50), fingers, mil scale alidade, or a ruler held a known distance from the eye. The angle subtended by each is determined by the individual before he goes into the field.

d. Lost. A round not seen by the observer is spotted *lost*. A spotting of *lost over* (*short*) may be made when the observer has accurate knowledge of the terrain. In such cases a bold range change is made to move the next burst into an area from which a positive spotting can be obtained.

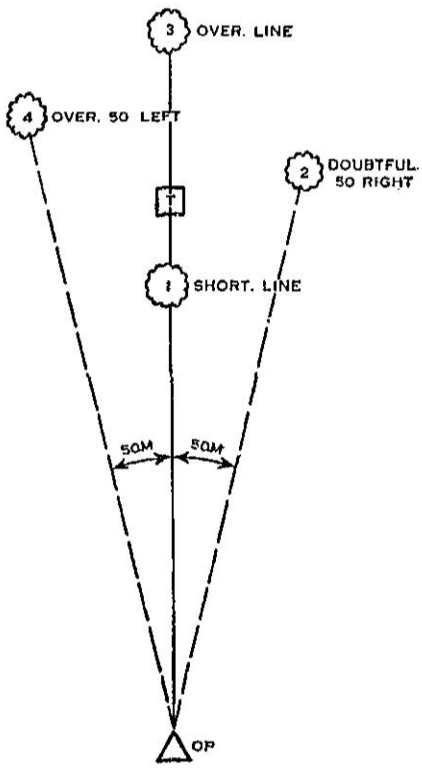


Figure 49. Spotting.

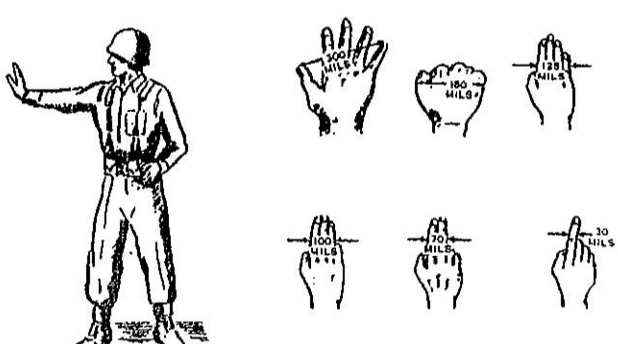


Figure 50. Examples of measuring angles with the hand.

144. Observer Within 100 Meters of the Mortar Position

The observer's best location for rapid fire adjustment is at the mortar position. Here his deviation spotting and the deflection correction to be placed on the sight are numerically equal. The tactical employment of the mortar, however, usually makes it necessary for the observer to be separated from the mortar. Nevertheless, the mortar should be placed, whenever possible, within 100 meters of the OP. If the observer takes a position in front, in rear, or to one side of the mortar position, but within 100 meters of it (fig. 51), the errors in deflection can be measured from the target to the burst by means of the mil scale in the binocular and applied directly to the mortar. This can be done because the MORT–TGT line is so close to the OT line that the two lines are the same for all practical purposes. For example, if the observer, from a position within 100 meters of the mortar location, spots the burst to be left of the target and reads 30 mils on the mil scale of his binocular, he orders a correction of RIGHT THREE ZERO.

145. Observer More than 100 Meters from the Mortar Position

When the mortar cannot be moved to within 100 meters of the OP, it should at least be placed so that the OP is within 100 meters of the MORT–TGT line. Then the MORT–TGT line and the OT line again are the same for all practical purposes. However, the deviation which the observer reads will not be the same as the deflection to be set on the mortar sight. If the observer is in front of the mortar, the deviation spotting will be greater than the deflection to be set on the mortar. For example, if he is halfway between the mortar and the target, his deviation spotting will be twice the correction to be made on the sight; if the mortar is halfway between the observer and the target, his deviation spotting will be half the correction to be made on the sight. Since other distances give other ratios, it is necessary to apply a correction factor to the number of mils spotted before ordering a deflection change. This factor is a fraction,

with the distance observer-target over the distance mortar-target; that is—

$$\text{Correction factor} = \frac{\text{Distance observer-target}}{\text{Distance mortar-target}}$$

$$\text{or } \frac{\text{OT}}{\text{MORT–TGT}}$$

For example, if the OT distance is 600 meters, the MORT–TGT distance is 800 meters, and the deviation of the burst from the target as read by the observer is 40 mils (fig. 51), the correction ordered is—

$$\frac{600}{800} \text{ (or } 3/4) \times 40 \text{ mils} = 30 \text{ mils}$$

In applying this factor, simplicity and speed should be sought. Therefore, distances used should be to the nearest even 100 meters.

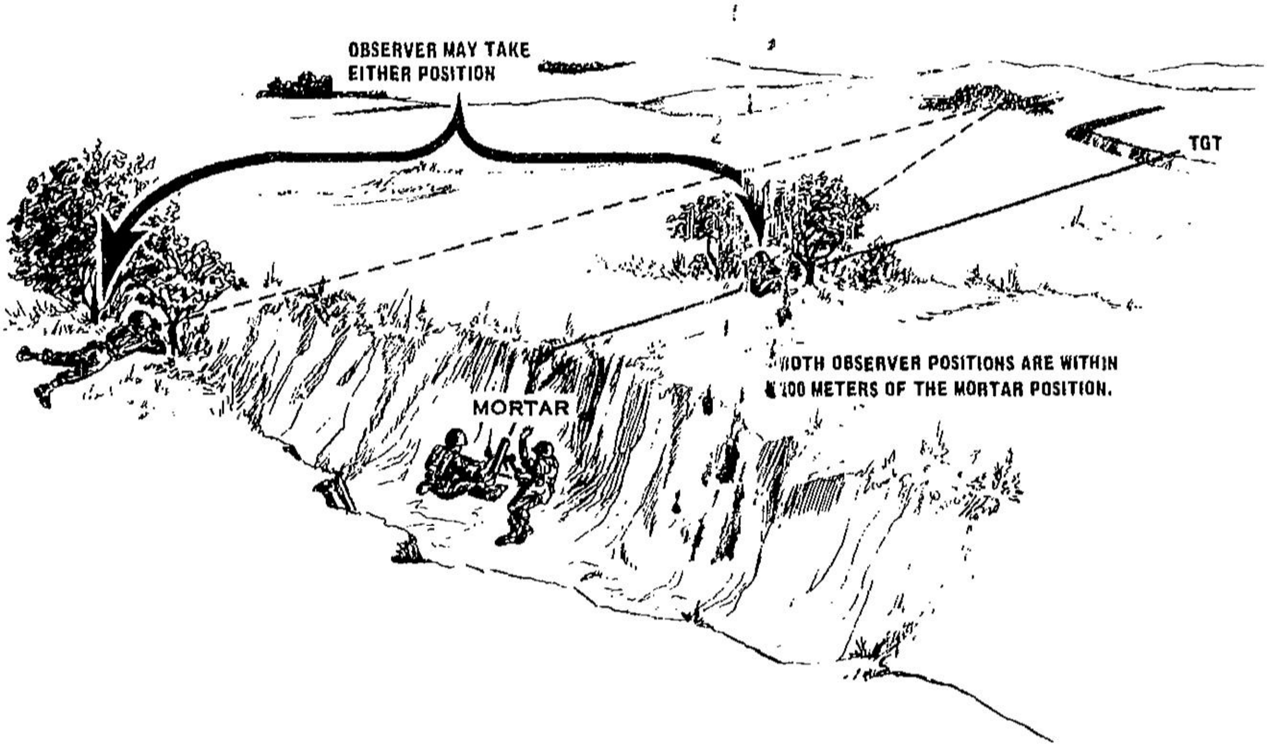


Figure 51. Observer within 100 meters of the mortar position.

Section V. FIRE COMMANDS

146. General

a. Origin and Transmission.

(1) Fire commands come from the leader at the observation post. These commands contain the technical instructions necessary for the gunner to lay the mortar for elevation and direction, and to fire.

(2) It is often desirable to give fire commands in fragmentary form as the elements of the command are determined. When given in this manner, the command can be executed while it is being given. Whenever practicable, give fire commands orally. When oral commands are not practicable, use telephone, arm-and-hand signals, or radio when available. The gunner repeats the elements of the fire command.

b. Numbers. Repeat all numbers given in a fire command, digit-by-digit, except when they are in even hundreds or even thousands, as follows:

50	FIVE ZERO
75	SEVEN FIVE
675	SIX SEVEN FIVE
700	SEVEN HUNDRED
1000	ONE THOUSAND
2400	TWO FOUR HUNDRED

c. Types. Fire commands are of two types: *initial fire commands* and *subsequent fire commands.* Both types of commands follow a definite sequence. Subsequent commands, however, include only such

elements as are changed, except that the range or elevation is always announced.

147. Initial Fire Commands

a. *Sequence.*

(1) Initial fire commands contain the data to lay the mortar and fire the first round. The sequence for transmission of fire commands is—

Mortar to follow command
Type of ammunition
Mortar to fire
Methods of fire (and restrictions)
Direction
Range (change and elevation)

(2) All fire commands follow this sequence; however, unnecessary elements are omitted.

b. *Elements.*

(1) The *mortar-to-follow-command* element serves two purposes; it alerts the mortar crews and it designates the mortars which are to follow commands. When the three mortars are operating as a unit, the command SECTION means that all mortars are to follow command. If the fire of only one mortar is desired, the number of that mortar is substituted for SECTION; that is, No. 1 and only that designated mortar crew follows the commands.

(2) The *type of ammunition* to be used is specified in the fire command as HE, SMOKE, or PRACTICE.

(3) The *mortar-to-fire* element designates the specific mortar or mortars which fire. The command to fire all mortars is SECTION. The command to fire a single mortar in a section firing position is NUMBER ONE (TWO). A squad leader leaves this element out of his fire command to his individual squad.

(4) The *method-of-fire* element designates the number of rounds and the manipulation to cover the target. Typical commands are: ONE ROUND; THREE ROUNDS; TRAVERSE RIGHT (LEFT) THREE TURNS; SEARCH EIGHT HUNDRED—SEVEN TWO FIVE; LADDER; and RIGHT (LEFT) ONE ROUND. In section fire to execute volley fire, each mortar fires the specified number of rounds regardless of the other mortars and as fast as accuracy permits. In section fire to execute RIGHT (LEFT) ONE ROUND, the mortars fire successively from right to left (left to right) at a designated time interval. For example, RIGHT AT FIVE SECOND INTERVALS. If no time is designated it is understood that the interval between rounds will be 5 seconds.

(5) The *direction element* gives the deflection and the *aiming point.* It is announced as ZERO (RIGHT, LEFT—), BASE (FIRST RIGHT, FIRST LEFT) POST, depending on the relation between the aiming point and the MORT-TGT line. The announced deflection is the exact total deflection to be placed on the sight. Although the aiming point may be any point that the gunner can lay his sight on, it is usually an aiming post. The aiming point may be given as BASE POST or as a numbered post to the right or left of the base post. For example, FIRST RIGHT POST, or SECOND LEFT POST (para 87). The deflection always precedes the aiming point. The *nearest post* is given as the aiming point in all initial fire commands, using 75 as the dividing line. When the direction is exactly halfway between two aiming posts (75 mils from both), the base post or the post nearest to the base post is used as the aiming point. It is desirable (but not always possible) to use the same aiming post throughout an adjustment. For example, for a target which is determined as 70 mils left of the base post, the direction sent to the gunner is LEFT SEVEN ZERO, BASE POST. For a target which is determined as 100 mils to the right of the base post, the direction sent to the gunner is LEFT FIVE ZERO, FIRST RIGHT POST. For a target which is determined as 230 mils to the left of the base post the direction sent to the gunner is RIGHT SEVEN ZERO, SECOND LEFT POST.

(6) The *range* is usually given in meters. For example, NINE FIVE ZERO. If the leader has a firing table he may give the charge and elevation. This is the control

element of every fire command, unless special instructions or restrictions have been given previously in the method of fire elements.

148. Examples of Initial Fire Commands

a. For a Single Mortar.

Mortar to follow command:	NUMBER ONE
Type of ammunition:	HE
Mortar to fire:	
Method of fire:	ONE ROUND
Direction:	ZERO, BASE POST
Range:	EIGHT HUNDRED

b. For a Section.

Mortars to follow commands:	SECTION
Type of ammunition:	HE
Mortars to fire:	NUMBER TWO
Method of fire:	ONE ROUND
Direction:	LEFT FOUR ZERO, FIRST RIGHT POST
Range:	SEVEN FIVE ZERO

149. Subsequent Fire Commands

Subsequent fire commands include only elements that are changed, except that the range or elevation is always announced. When a change is made in the *mortars to fire* or in the *method of fire*, include both elements in the subsequent command.

a. Corrections in Direction. Give corrections in direction in mils as: RIGHT ONE ZERO; LEFT TWO FIVE. When the direction is correct, this element is omitted in the subsequent fire command. The gunner must apply the deflection correction algebraically to the previous deflection setting on the sight. For example, the gunner has a deflection on his sight of RIGHT FIVE ZERO and receives a deflection correction of LEFT THREE ZERO. His new sight setting should be RIGHT TWO ZERO.

b. Correction in Range. Always include this element in the subsequent fire command. For example, SIX FIVE ZERO. If the range does not change, give the command (same range or elevation) EIGHT HUNDRED or SEVEN FIVE ZERO.

c. Cease Firing and Suspend Firing.

(1) CEASE FIRING is announced when an emergency condition arises and it is imperative that firing be discontinued immediately. Cease fire may be announced by any one that discovers such a condition. Firing may be resumed as soon as the emergency condition has been eliminated.

(2) SUSPEND FIRING indicates a temporary pause in firing and allows it to be resumed with the same data by the use of the command RESUME FIRING.

d. Termination of Alert. The end of the alert is announced as: END OF MISSION. This allows the mortar crew to relax between fire missions so that they can respond to subsequent alerts more completely. The gunner automatically lays on the base post with a deflection of zero and an elevation of 62° or, in a defensive situation, with the elevation and deflection for the barrage.

150. Examples of Subsequent Fire Commands

a. For a Single Mortar:

Method of fire:	FOUR ROUNDS
Direction:	RIGHT TWO ZERO
Range:	SEVEN FIVE ZERO

b. For a Section:

Mortars to fire:	SECTION
Method of fire:	FOUR ROUNDS AT MY COMMAND
Direction:	LEFT ONE ZERO
Range:	EIGHT HUNDRED

151. Modified Fire Commands

a. Modified subsequent commands differ from normal subsequent commands only in that the deflection and range changes in modified subsequent commands are given as turns of the traversing handwheel and turns of the elevating crank. The advantages of modified fire commands are speed and simplicity of execution by the gunner. One turn of the traversing handwheel is equal to about 15 mils of deflection while one turn of the elevating crank is equal to about ½° change in elevation. All commands given for deflection or elevation changes are given to the nearest half turn.

b. The gunner lays the mortar for direction and elevation as in the initial fire command. He does not need to refer to a firing table. After the initial fire command, he makes no attempt to aline the sight on the aiming point or to level the longi-

tudinal bubble. He makes the corrections by taking the turns given in the subsequent commands and keeping the cross-level bubble centered.

c. In computing the number of turns of the elevating crank between two elevations in degrees (taken from the firing table), it is necessary to subtract the smaller elevations from the larger and then multiply this difference by two (two turns of the elevating crank being equal to 1° of elevation). All fractions of degrees are disregarded when making this computation.

d. When the squad leader-observer intends to employ modified subsequent commands, he should express the range element of the initial command in terms of charge and elevation rather than in meters.

152. Examples of Fire Commands

Initial fire commands

NUMBER ONE	NUMBER ONE
HE	HE
ONE ROUND	ONE ROUND
ZERO, BASE POST	ZERO, BASE POST
NINE HUNDRED	CHARGE THREE ELEVATION SEVEN ZERO
Normal fire commands	*Mod'fied fire commands*
RIGHT SIX ZERO	RIGHT FOUR TURNS
SEVEN HUNDRED	UP TEN TURNS
LEFT THREE ZERO	LEFT TWO TURNS
EIGHT HUNDRED	DOWN FIVE TURNS
RIGHT ONE FIVE	RIGHT ONE TURN
EIGHT FIVE ZERO	DOWN TWO AND ONE-HALF TURNS
THREE ROUNDS	THREE ROUNDS
EIGHT TWO FIVE	UP ONE AND ONE-HALF TURNS

Note. In the example, the elevation element in the *initial fire command* is given in degrees and charge (70°, charge 3). This first round bursts beyond the target. Assume that the next round is to be fired at a range of 700 meters. The elevation for 700 meters, using charge 3, is 75°. To compute the number of turns of the elevating crank needed to elevate the mortar from 70° to 75°, the leader-observer subtracts 70° from 75° (dropping all fractions). The difference is 5° or 10 turns (since two turns of the elevating crank are equal to 1° of elevation). The elevation change in his next command is UP TEN TURNS. Assuming that this second round bursts between the observer and the target and so makes a bracket of the target, the observer desires to split the bracket (para 158). He merely commands DOWN FIVE TURNS (one-half the number of turns that he had previously given to bracket the target). Assuming that this burst is still between the observer and the target, he has a 5-turn (100-meter) bracket of the target. Splitting the bracket, the observer commands DOWN TWO AND ONE-HALF TURNS. Assuming that this burst is beyond (over) the target, the observer now has a 3-turn (50-meter) bracket of the target. The adjustment is completed by splitting the number of turns of elevation—three. The next command then is UP ONE AND ONE-HALF TURNS.

153. Arm-and-Hand Signals

There may be occasions when it is necessary to control mortar fire by arm-and-hand signals. The observer gives his arm-and-hand signals while facing the mortar position. He gives the deflection signals in the direction the correction is to be taken regardless of which arm he uses. As there are no prescribed signals for indicating the elements of an initial fire command, the following may be used:

a. Are You Ready? This is the first signal in any series. The observer extends one arm toward the gunner, his hand raised, fingers extended and joined, palm toward the gunner. The gunner gives his reply I AM READY in the same way.

b. Commands. For the *mortars to follow commands* in section fire, all mortars follow commands unless otherwise indicated. To designate a particular mortar, the observer points to that mortar.

c. Type. For *type of ammunition*, HE is understood unless otherwise indicated. For smoke, the palms of both hands are placed over the eyes.

d. Zero Deflection. Zero deflection is used unless otherwise indicated.

e. Deflection Right (Left). The observer faces the mortar, extends one arm toward the gunner, and swings that hand and arm horizontally in the direction in which the fire is to be shifted, palm turned in that direction. The first sweeping horizontal movement of his hand and arm represents a 5-mil change in deflection. Each subsequent movement of his hand and arm, after return to the starting position, represents an additional 5-mil change in deflection.

f. Aiming Point. The base stake is used as the aiming point unless otherwise indicated. The observer faces the mortar, and with his arm and hand extended, points in the desired direction (left for right posts, etc.). One such movement of the arm and hand indicates the first post. Each subsequent movement, after he returns his arm to his side, indicates an additional post in the direction pointed.

g. Mortars to Fire (in section fire). The observer designates the mortar to fire by pointing at the mortar or mortars.

h. Number of Cartridges. For each cartridge to be fired, the observer extends one arm above his head, palm toward the gunner, and cuts his hand sharply downward.

i. Range or Change in Elevation. Facing the mortar, the observer raises one arm laterally until horizontal, arm extended and fist closed. For each range increment of 100 meters, he raises his arm, fully extended, to an overhead position and returns it to the horizontal. For each 25-meter increase, he thrusts his fist upward, vertically, from his shoulder to the full extent of his arm and returns it. For a range of 750 meters, he raises his arm seven times and his fist twice. He gives the complete range in each command.

j. Command to Fire. The observer raises one arm fully extended, to an overhead position. For the signal to commence firing, he sweeps his arm quickly down through an arc to the front all the way to the relaxed position of the arm with his hand by his thigh.

k. Failure to Understand Command. If the gunner does not understand any part of the command, he raises both arms to their full extent over his head and crosses them several times. On this signal the observer repeats the entire command.

154. Repeating and Correcting Commands

a. Repeating Commands. When the gunner fails to understand any element of the fire command, he requests a repetition of that element by announcing, "Say again the deflection (elevation)." When any crewmember asks that any element be repeated, avoid a misunderstanding by prefacing the repeated element with the phrase THE COMMAND WAS________.

b. Corrections. In all initial fire commands, correct an incorrect element by announcing: CORRECTION, and giving the correct element. For example, to correct an erroneous range of SIX HUNDRED to a correct range of SEVEN HUNDRED, announce the following command: CORRECTION, SEVEN HUNDRED. When an erroneous element is given in a subsequent fire command, the procedure is as follows: announce CORRECTION and then give the entire command.

Section VI. SQUAD CONDUCT OF FIRE

155. General

a. Conduct of fire includes all operations in the preparation and application of fire on a target. It includes the squad leader's (observer's) ability to open fire when he desires, to adjust fire, to determine the distribution of fire upon the target, to shift fire from one target to another, and to regulate the kind and amount of ammunition expended. It involves the action and teamwork of all members of the unit.

b. The normal sequence of training in squad conduct of fire is: First, training on the 1,000-inch range; next, training on the training cartridge range; and last, training in the field with practice and combat ammunition.

c. For maximum efficiency, every member of the squad learns the technique of fire for each type of adjustment and fire for effect. Frequent rotation of duty insures complete understanding of this technique of fire by all the squad members. The observer is trained in all the methods and mechanics used to bring effective fire on a target in the least time.

156. Fire Adjustment

The observer adjusts fire to obtain correct fire data with which to fire for effect. By watching the bursts, he makes his spottings and gives subsequent corrections to place the next burst where he wants it. Since positive spottings are most readily obtained when bursts are on the OT line, he brings the bursts to the OT line and keeps them on that line. The observer makes his corrections for range and deflection so that the center of impact is on or near the target. Depending upon the nature of the target, speed with which fire for effect is desired, and the position of the target with respect to friendly troops, the observer will adjust fire by one of three methods: bracketing, creeping, or ladder.

157. Bracketing Method of Adjustment

a. The basic method of adjusting mortar fire is by bracketing the target for range. A target is bracketed for range when one round bursts between the observer and the target and one round bursts beyond the target. The purpose of bracket-

ing is to inclose the target within a range bracket of suitable depth, with correct deflection. The area containing the target can then be covered by fire for effect. This is done by establishing an initial range bracket and, thereafter, successively splitting the brackets formed by the last over and the last short.

b. After a round has been spotted as over or short of the target, the observer makes the first range change large enough to insure a bracket for the target. It is better to overestimate the corrections than to underestimate them because in this way a bracket is more quickly obtained. The observer makes the size of the initial range change in hundreds of meters. Unless there is a definite indication of the amount of range error, the size of the initial range change depends on the distance from the observer to the target. As a general rule, the minimum range change to get a bracket is 100 meters when the estimated OT range is less than 1,000 meters, and 200 meters when the OT range is greater than 1,000 meters. The reason for this rule is that at the shorter distances observation of the target and the burst is easier and range estimation is more accurate. At greater distances, target observation, spotting, and range estimation are more difficult.

c. Make the subsequent range changes in hundreds of meters until a 50-meter bracket has been established. Start fire for effect at the center of the 50-meter bracket. If during adjustment a target hit is obtained, start fire for effect immediately. When a bracket has been established but a subsequent round is obviously erratic, because of faulty ammunition or other causes, fire another cartridge with the same data.

d. Experience has proved that the bracketing method of adjustment is the most economical in ammunition expenditure and, except where time is the governing factor, the most effective under normal combat conditions. Attempts to estimate accurately the distance between the burst and the target are seldom successful because of human inability to estimate accurately the distance between two points in depth. The bracketing method makes it unnecessary to do this. The observer merely determines whether the burst is between himself and the target or beyond the target. This method works in practically all situations. Even when firing at a target on the crest of a hill, the bursts between the observer and the target can be observed as short and all unobserved rounds are spotted as over.

e. Example—

(1) A squad leader sees a target and desires to adjust fire on it by the bracketing method. He estimates the MORT–TGT range to be 800 meters, determines the MORT–TGT azimuth, directs that the mortar be mounted on this azimuth (para 137), and issues the following initial fire command:

NUMBER ONE
HE
ONE ROUND
ZERO, BASE STAKE
EIGHT HUNDRED

(2) The gunner, upon receiving this fire command, repeats it, consults his firing table, checks the elevation corresponding to a range of 800 meters (73°), sets the elevation in degrees on the sight, and announces the charge (charge 3) with which the cartridge is to be fired. He then lays the mortar as described in paragraph 83 and commands FIRE. This round bursts between the observer and the target and 20 mils to the left as shown in figure 52.

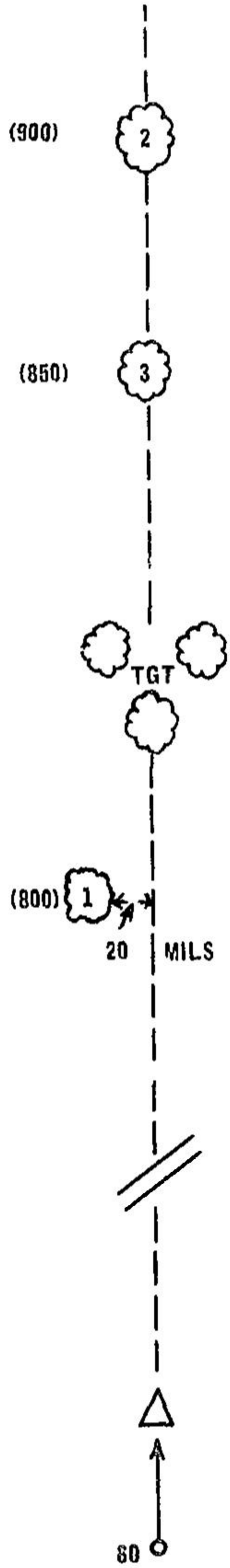
(3) The observer senses this burst and issues a subsequent fire command correcting the deflection and increasing the range to get a burst beyond the target, thereby obtaining a bracket. Since the OT range is less than 1,000 meters and the range error appears to be small, he makes an initial range change of 100 meters.

Note. If the baseplate has not been already settled, and the burst of the first round is on or near the target, the next cartridge fired at the same elevation usually results in a burst beyond the target. In such cases, when the tactical situation permits, a confirming cartridge is fired and a more definite spotting obtained. If this confirming cartridge bursts on the target, fire for effect is delivered immediately; otherwise, the observer continues the bracketing adjustment.

(4) Continuing the example illustrated in figure 52, the subsequent fire command is—

RIGHT TWO ZERO
NINE HUNDRED

The gunner sets a deflection of right 20 mils on the sight, places the elevation on his sight, lays the mortar, and commands FIRE. The second cartridge bursts be-



INITIAL FIRE COMMANDS

NUMBER ONE
HE
ZERO, BASE STAKE
ONE ROUND
EIGHT HUNDRED

OR

NUMBER ONE
HE
ZERO, BASE STAKE
ONE ROUND
SEVEN THREE

SUBSEQUENT COMMANDS

(NORMAL)	(MODIFIED)
RIGHT TWO ZERO NINE HUNDRED	RIGHT ONE AND ONE- HALF TURNS DOWN FIVE TURNS
EIGHT FIVE ZERO	UP TWO AND ONE HALF TURNS
THREE ROUNDS EIGHT TWO FIVE	THREE ROUNDS UP ONE AND ONE- HALF TURNS

Figure 52. Bracketing method of fire adjustment.

yond the target and on the OT line as shown in figure 52. The deflection is now correct and a 100-meter bracket has been obtained. The next subsequent fire command issued by the observer is—

EIGHT FIVE ZERO

The gunner places the elevation in degrees on the sight, relays the mortar, and fires the next cartridge. The round bursts beyond the target and on the OT line (fig. 52). The observer has now spotted a burst over at 850 meters and a burst short at 800 meters. This establishes a 50-meter range bracket. His next fire command combines fire for adjustment with fire for effect.

THREE ROUNDS
EIGHT TWO FIVE

(5) The bursting of these three rounds and their normal dispersion covers the target area with casualty-producing fragments. When fire for effect fails to cover the target adequately, the observer orders any necessary changes in deflection and range and again orders fire for effect. Where the target is near the outer limit of the bursting area of most of the rounds, and where a 25-meter range change is too great, a small change in elevation such as down one turn (up one turn) may be given before fire for effect is repeated.

Note. This adjustment can be fired using modified fire commands (fig. 52).

158. Creeping Method of Adjustment

a. When friendly troops are within 300 meters of the target the creeping method of adjustment is used. Fire delivered on targets within 100 meters of friendly troops may cause casualties among those friendly troops. When the target is more than 300 meters from our own troops, the bracketing method is used.

b. The procedure for the creeping method is as follows: The observer estimates the MORT–TGT range and then adds 100 meters as a safety factor. The first cartridge is fired at a range equal to the estimated MORT–TGT range plus the safety factor (100 meters). The MORT–TGT range for each subsequent cartridge of the adjustment is decreased by one-half the estimated range error (overage) of each burst from the target, until a correct range is obtained. The observer does not make a range change of less than 25 meters. When a target hit is obtained, he orders fire for effect. If a round falls short of the target after a 25-meter range decrease, the observer orders fire for effect at the range of whichever of the last two cartridges seemed closer to the target. If a short round results from a decrease in range of more than 25 meters, the observer has a bracket and continues the adjustment with the bracketing procedure (para 157).

c. Example—

(1) An observer determines the MORT–TGT range to be 800 meters. Friendly frontline troops are within 300 meters of the target. Therefore, he adds a safety factor of 100 meters to the MORT–TGT range. His initial fire command is—

NUMBER THREE
HE
ONE ROUND
ZERO, BASE STAKE
NINE HUNDRED

The first cartridge is fired and it bursts beyond the target and to the left of the OT line (fig. 53). The observer estimates the burst to be 100 meters beyond target and measures a deflection error of left 20 mils. His subsequent fire command is—

RIGHT TWO ZERO
EIGHT FIVE ZERO

(2) The MORT–TGT range of 850 meters is obtained by taking one-half of the estimated overage, or 50 meters, as a range change for the next cartridge. Thus, the second cartridge is fired at a range of 850 meters. This round bursts as shown in figure 53, five mils to the left of the OT line, and the observer estimates the distance to be 50 meters beyond the target. His subsequent fire command is—

RIGHT FIVE
EIGHT TWO FIVE

(3) In determining the MORT–TGT range for the third cartridge, the observer again uses one-half of the estimated overage, or 25 meters. Therefore, the third cartridge is fired at a range of 825 meters. The deflection setting on the sight at this time is right 25 mils (20 plus 5). The third cartridge bursts beyond the target and on the OT line (fig. 53). The observer estimates that this burst is 25 meters be-

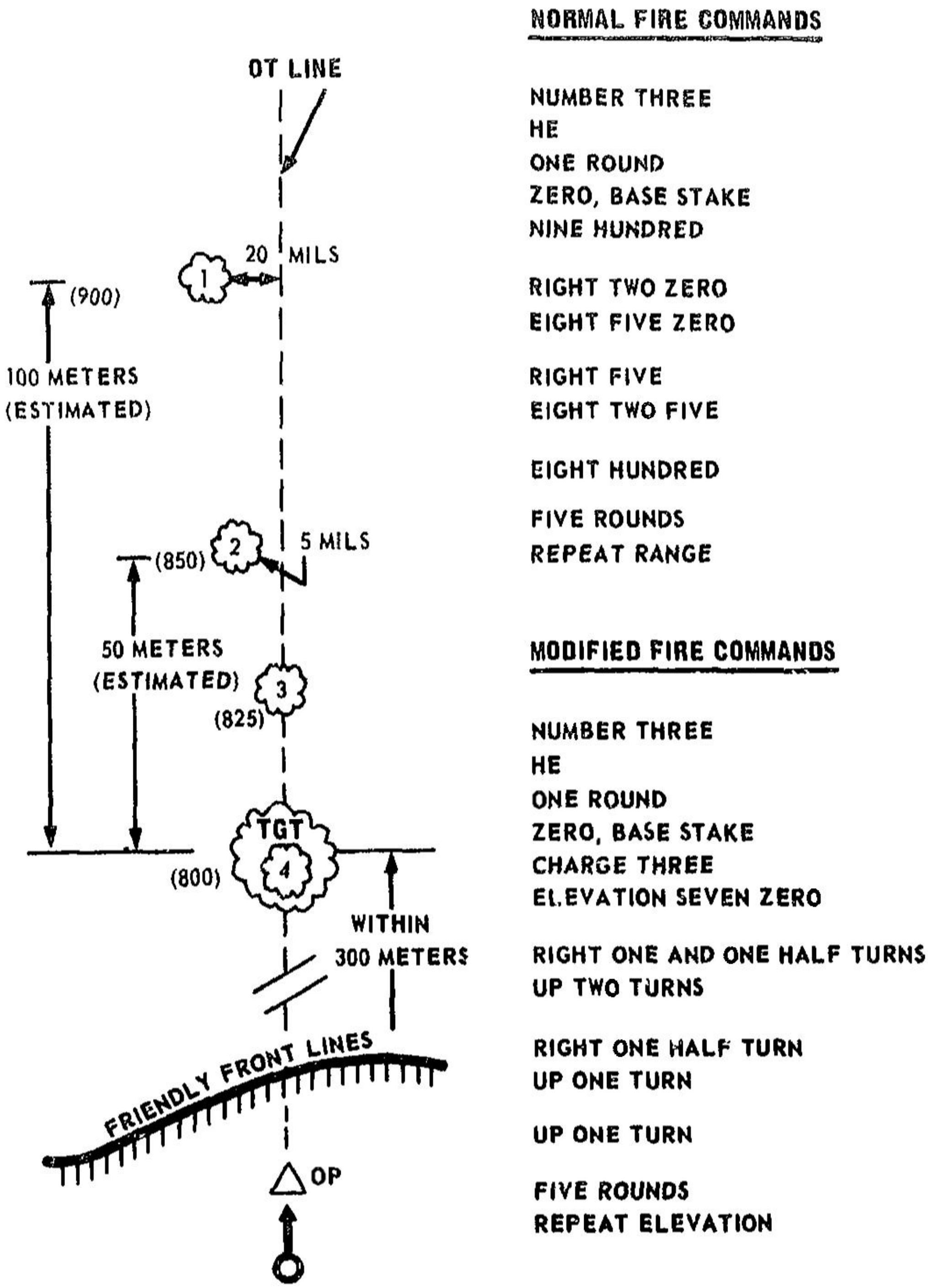


Figure 53. Creeping method of fire adjustment.

yond the target. Since 25 meters is the smallest range change made with the mortar, the next cartridge is fired at a range of 800 meters (a range change of 25 meters). His next subsequent fire command is—

EIGHT HUNDRED

The observer continues to decrease the range 25 meters at a time until he secures a target hit or a short. If a round falls short of the target, he has obtained a 25-meter bracket of the target and to fire for effect selects the range of the bracket-

ing round which seemed closer to the target.

Note. This adjustment can be fired using modified comm. .ds (fig. 5?).

159. Ladder Method of Adjustment

a. As surprise is an important factor in placing effective fire on a target, any form of adjustment which reduces the time interval between the first round for adjustment and fire for effect is worthy of study and use. The ladder method of adjustment is a modification of the bracketing method of adjustment which permits fire for effect to be delivered more rapidly. Knowledge of the bracketing method of adjustment is necessary for the effective use of the ladder method of adjustment. A base point which has already been established by firing is desirable to assist the observer in determining the range to the new target.

b. For a mental picture of the ladder method of adjustment, imagine a giant ladder with rungs 50 meters apart, lying on the ground near the target It is easy to figure the exact range to the target, if the range to each of the rungs near the target is known. Instead of rungs on a ladder, substitute round bursts placed in the vicinity of the target, at 50-meter intervals. Three cartridges fired at 50-meter range intervals would make rungs of a huge ladder on the ground, provided they fell a few seconds apart so that all rounds could be observed at the same time. This actually is the ladder method of adjustment. There are 50 meters between bursts in a 100-meter ladder and 100 meters between bursts in a 200-meter ladder. A 100-meter ladder is used with the 60-mm mortar when the MORT–TGT range is 1,000 meters or less. A 200-meter ladder is used whenever the range is greater than 1,000 meters.

c. The ladder adjustment is used on terrain which, from previous firing, is familiar to the observer. The saving in time is the most important advantage of this method of adjustment; however, its success is limited by accurate range estimation. The target must be bracketed between two rungs of the ladder. If none of the three rounds bracket the target, but all burst beyond the target or between the target and the observer, ammunition is wasted because it is necessary to fire another ladder or to continue the adjustment using the normal bracketing method. When the center of impact of the cartridges fired for effect is off the target any appreciable distance, another correction has to be made and fire for effect repeated.

d. For most accurate results, the baseplate of the mortar must be settled before firing a ladder. A baseplate can be firmly seated by firing one cartridge at a relatively high angle of elevation, using charge 3 or 4.

e. Example—

(1) The observer obtains the initial direction by any of the methods prescribed in paragraphs 134 and 135. He estimates the range MORT–TGT (assume 800 meters), adds 50 meters to this estimated range to establish one range limit for the ladder, and subtracts 50 meters to establish the other limit (100-meter ladder). This should result in a ladder which straddles the target. To help in spotting, the cartridges are fired in the order: far, middle, and near. Fired in this order, no burst is obscured by the dust and smoke from a preceding burst. The following is an initial fire command for the ladder method of adjustment:

NUMBER TWO
HE
LADDER, SEARCH UP FOUR TURNS
RIGHT ONE ZERO, BASE POST
CHARGE FOUR
ELEVATION SEVEN SEVEN

Note. The method of fire element in the normal initial fire command for the ladder contains the word LADDER and manipulating instructions for the gunner to take *between* cartridges. The charge and elevation given correspond to the range of the first (far) cartridge.

(2) To calculate the turns which the gunner must take between cartridges, the observer must determine the total number of degrees between the extreme ranges of the ladder by consulting the firing tables. Disregard all fractions while computing the total degrees.

(3) Convert the total degrees of the ladder into turns of the elevating crank. This is accomplished by multiplying the total degrees by two (one turn of the elevating crank will elevate or depress the tube ½°).

(4) Divide the total turns of the elevating

crank by the number of intervals between cartridges in the ladder. The answer will be the number of turns between cartridges.

f. Example—

(1) Estimated range 800 meters. The ladder is fired at ranges 850, 800, and 750. To calculate turns between cartridges: Range 850, chg 4, elev 76° (disregard fractions). Range 750, chg 4, elev 77° (subtract smaller from larger: 77° minus 76° = 1°). This indicates TOTAL DEGREE(S). Convert degrees to turns of the elevating crank—1×2=2. This is total turns. Divide intervals into total turns—2 divided by 2=1. This indicates the turns between cartridges for the gunner.

Note. The number of intervals will always be less than the number of cartridges to be fired.

(2) The gunner sets his sight for deflection at right 10 mils and an elevation of 76°. He lays the mortar and fires the first cartridge. He then relevels the longitudinal bubble, searching up one turn, cross-levels, and fires the second cartridge. He searches up one more turn, cross-levels and fires the third cartridge. The three cartridges are fired as rapidly as possible.

(3) These rounds burst as shown in figure 54. Note that the average deflection error of the three cartridges fired is 15 mils. This must be converted to a deflection correction to be applied to the mortar. This is done by dividing the deflection of 15 mils by 15 (one turn of the traversing handwheel is equivalent to approximately 15 mils) with the resulting correction being announced to the gunner. The three cartridges, falling almost simultaneously, have straddled the target, and, from their position with respect to the target, indicate to the observer that the target is between the bursts of the second and third cartridges. The observer now has a 50-meter bracket of the target. He splits the bracket by taking one-half the number of turns between the two bursts and applying it to the mortar, moving the tube in the opposite direction. His next fire command, correcting for deflection and splitting the 50-meter bracket is—

FIVE ROUNDS
RIGHT ONE TURN
DOWN ONE-HALF TURN

Note. In computing the deflection correction, the observer makes sensing for each cartridge fired and determines the average by dividing the total deflection error by the number of cartridges fired (add algebraically where necessary). He then converts this to turns of the traversing handwheel and announces his correction to the nearest one-half turn. To make a correction for range when the target is bracketed within the ladder, the mortar must be moved in the opposite direction (down). The conditions for fires for effect are the same as outlined in paragraph 160.

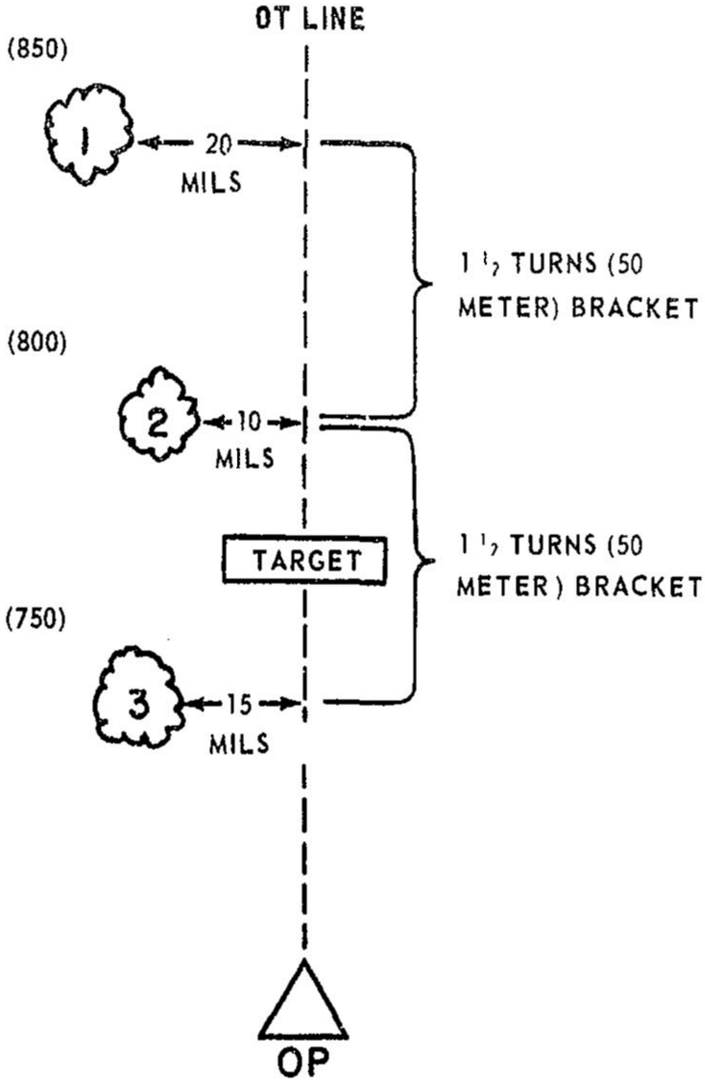
160. Fire for Effect

a. Fire for effect is used to destroy a target or to accomplish a desired tactical result. First, adjust mortar fire for deflection and range. Then start fire for effect at the center of the selected bracket. However, in the creeping method of adjustment, fire for effect when the adjustment is satisfactory. Here the observer combines fire for adjustment with fire for effect.

b. The observer determines the number of cartridges to be fired for effect according to the size of the target, the nature of the target, and the ammunition available. The sizes of targets for fixed and distributed fires, paragraphs 161 and 162, are given as a guide only in determining the number of cartridges to be fired for effect. For example, troops or weapons in foxholes require more fire for neutralization than troops or weapons in the open.

161. Fixed Fire

The 60-mm mortar is normally used against definitely located point or small area targets such as crew-served weapons and small groups of enemy personnel, particularly those in defilade. Three cartridges, fired from a single mortar at the same elevation and deflection, cover an area approximately 35 by 35 meters with casualty-producing fragments. When more than three cartridges are fired for effect on a point target, such as final protective fire, the area covered by casualty-producing fragments is approximately 50 by 50 meters. This results from the dispersion and the bursting area of the rounds. The gunner checks the lay of the mortar for elevation and deflection



MODIFIED FIRE COMMANDS

NUMBER TWO
HE
LADDER, SEARCH UP FOUR TURNS
RIGHT ONE ZERO, BASE STAKE
CHARGE TWO
ELEVATION SEVEN SIX

FIVE ROUNDS
RIGHT ONE TURN
DOWN ONE AND ONE HALF TURNS

Figure 54. Ladder method of fire adjustment.

during firing for effect. If the center of impact of the rounds fired for effect is not on or near the target, fire for effect may be repeated with slight adjustments made for range and deflection.

162. Distributed Fire

The 60-mm mortar may occasionally be used against targets that extend laterally or in depth, or both, by *traversing* or *searching* fire. Areas to be covered with 60-mm mortar fire are often limited by the traverse of the weapon (approximately 250 mils) and the inability of the weapon to neutralize large areas without a great expenditure of ammunition. On the other hand, when a large amount of ammunition is available, area targets can be covered effectively with 60-mm mortars. A single 60-mm mortar, firing four cartridges properly distributed in width or depth, covers a target approximately 75 meters in width or depth with casualty-producing fragments. An area target approximately 75 by 75 meters can be covered with a single mortar by a series of traversing or searching fires. A section of 60-mm mortars, mounted parallel with 75 meters between flank mortars and firing four cartridges per mortar properly distributed in width or depth, can effectively cover 225 meters with casualty-producing fragments. This section can cover an area target approximately 225 meters by 75 meters by executing a series of traversing or searching fires.

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As targets of this size require a large amount of ammunition, they are not assigned normally to a 60-mm section.

a. Traversing Fire.

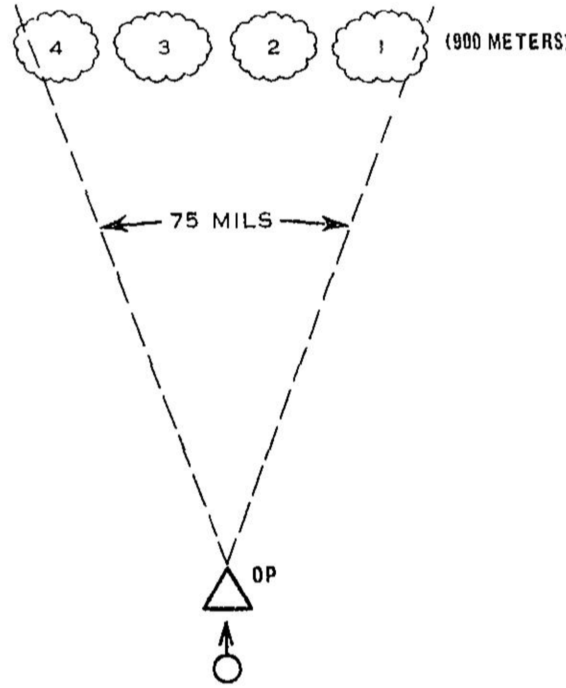
(1) The width of a target for a single mortar should not exceed 75 meters. (Targets which are 75 meters in width cannot be engaged effectively at ranges less than 500 meters because of the mortar's limited traverse.) Four cartridges equally distributed across such a target cover it with casualty-producing fragments. When a heavier concentration of fire is desired, the number of cartridges may be increased. After each cartridge is fired, the gunner traverses the mortar the number of turns or fractions of turns (never less than a half turn) of the handwheel specified in the command.

(2) The observer determines the number of turns of the traversing handwheel between cartridges as follows:

(*a*) Measure the width of the target in mils.

(*b*) Divide the mil width of the target by 15 to measure the width of the target in turns of the traversing handwheel.

(*c*) Divide the total number of turns by the number of intervals between cartridges (one less than the total number of cartridges to be fired). Compute the turns to the nearest half. In other words, when four cartridges are to be distributed across the target for effect, divide the mil width of the target by 45 since each turn of the traversing handwheel is equivalent to 15 mils and there are three intervals between the four bursts (fig. 55).



THE OBSERVER DETERMINES THE WIDTH OF THE TARGET TO BE 75 MILS.
HE COMPUTES THE WIDTH OF THE TARGET IN TURNS OF THE TRAVERSING HANDWHEEL BY DIVIDING 75 MILS BY 15 (THE NUMBER OF MILS IN ONE TURN OF THE TRAVERSING HANDWHEEL) AND FINDS IT TO BE 5 TURNS.
HE DIVIDES THE TOTAL NUMBER OF TURNS BY 3 (THE NUMBER OF INTERVALS BETWEEN ROUNDS) AND FINDS THE NUMBER OF TURNS BETWEEN ROUNDS TO BE 1½ TO THE NEAREST ½ TURN.
THE COMMAND FOR FIRE FOR EFFECT IS:
FOUR ROUNDS
TRAVERSE LEFT ONE AND ONE-HALF TURNS
NINE HUNDRED

Figure 55. Traversing fire.

(3) When a target is not completely covered in depth by a single traverse across its width, the fire may be repeated, changing only the direction of traverse and the range.

b. *Searching Fire.*

(1) The depth of a target for a single mortar should not exceed 75 meters. Use the same method in distributing fire over a target in depth as in delivering traversing fire, the gunner depressing (or elevating) the mortar, after each cartridge, the proper number of turns of the elevating crank which he determines from the ranges given in the command.

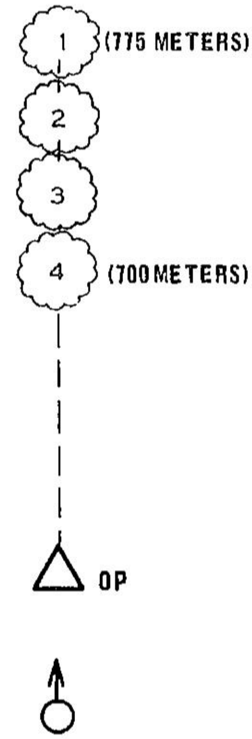
(2) The mortar is first laid with an elevation corresponding to the range of either the far or near limits of the target depending upon which range is indicated first in the command. The number of turns of the elevating crank between cartridges is determined as follows:

(*a*) Look up the elevations for the ranges to the far and near limits of the target, and subtract the smaller from the larger after dropping all fractions.

(*b*) Multiply the difference between the elevations by 2 to get the total number of turns of the elevating crank necessary to elevate or depress the mortar from one limit of the target to the other.

(*c*) Divide the total number of turns of the elevating crank by the number of intervals between cartridges (one less than the total number of cartridges to be fired). See figure 56 for method of computing the number of turns between two elevations in degrees.

(3) When a target is not completely covered in width by a single searching action over its length, the fire may be repeated, changing only the direction of search and the deflection.



THE OBSERVER DETERMINES THAT THE TARGET IS APPROXIMATELY 75 METERS DEEP AND ISSUES THE FOLLOWING SUBSEQUENT FIRE COMMAND.

FOUR ROUNDS
SEARCH 775–700

THE GUNNER LOOKS UP THE ELEVATIONS FOR BOTH RANGES INDICATED IN THE FIRE COMMAND AND FINDS THEM TO BE 77 AND 78 RESPECTIVELY. HE DETERMINES THE DIFFERENCE BETWEEN THESE ELEVATIONS AFTER DROPPING FRACTIONS TO BE 1°.

HE MULTIPLIES 1° X 2 AND DETERMINES THE TOTAL NUMBER OF TURNS OF THE ELEVATION CRANK NECESSARY TO ELEVATE THE MORTAR FROM THE FAR LIMIT OF THE TARGET TO THE NEAR LIMIT TO BE 2 TURNS.

HE THEN DIVIDES 2 X 3 (NUMBER OF INTERVALS BETWEEN ROUNDS) AND FINDS THE NUMBER OF TURNS BETWEEN ROUNDS TO BE ½ TO THE NEAREST ½ TURN. HE ELEVATES THE MORTAR ½ TURN BETWEEN ROUNDS TO DECREASE THE RANGE.

Figure 56. Searching fire.

163. General

When the 60-mm mortar is used as a handheld mortar, it may become a direct-fire weapon and normally is fired at ranges of not more than 500 meters. As a direct fire weapon, no particular method of adjusting fire is required. If the first burst is not effective, the mortar is moved slightly in elevation or deflection to bring the next burst nearer the target. Fire for effect is always fixed fire of from three to five cartridges according to the nature of the target. The normal crew for the handheld mortar is a gunner and assistant gunner; however, it can be employed by one man.

164. Procedure

a. The crew should be in partial defilade. This gives some protection from enemy direct fire while the gunner can still engage the target by direct laying. The gunner may take either the kneeling or sitting position. He alines the mortar for direction by sighting over the barrel at the target. The elevation at which the mortar is held must be estimated for the first cartridge and then raised or lowered to correct the range for succeeding rounds. The following table is accurate only when the target is at the same elevation as the mortar and it should be used only as a guide during training. After firing a few cartridges with the handheld mortar, a gunner has little trouble holding the mortar at an elevation to place the first round near the target. Various types of sights for the handheld mortar have been tested but none are of much assistance to a gunner at the short ranges for which the handheld mortar is used.

Low trajectory fire:

Range (meters)	*Elevation (degrees)*	*Charge*
100	5	0
200	15	0
300	25	0
400	10	1
500	15	1
600	20	1
700	25	1
800	35	1

High trajectory fire:

Range (meters)	*Elevation (degrees)*	*Charge*
100	80	0
200	70	0
300	60	0
400	75	1
500	70	1
600	65	1
700	60	1
800	50	1

b. When the first cartridge is not effective, the gunner corrects for deflection or range by moving the barrel to the left or right and by lowering or elevating the barrel. To increase the range when firing with an elevation less than 45° (low-trajectory fire), he must *elevate* the barrel. On the other hand, to increase the range when firing with an elevation greater than 45° (high-trajectory fire), he must depress the barrel. Definite movements must be made in correcting the fire of the handheld mortar. The gunner's normal tendency is to ease the barrel in the direction of correction. Because of this tendency he often fails to make large enough corrections.

c. When a partial defilade position cannot be used, the handheld mortar may be fired as an indirect-fire weapon (gunner cannot see the target). Then the gunner takes the sitting position and is directed by an observer in pointing the mortar in the direction of the target and with an estimated elevation. The observer uses informal verbal commands or arm-and-hand signals. In adjusting, the observer directs the gunner to move the barrel left or right and to elevate or depress it. The gunner should make bold movements of the barrel for the initial adjustments on a target to eliminate a close type of adjustment.

d. To illustrate the use of the handheld mortar, assume that a handheld mortar crew is accompanying the leading elements of its company in the attack. An enemy machinegun in view of the mortar crew opens fire and stops the advance.

(1) The gunner immediately unslings the mortar from his shoulder and takes the sitting position in partial defilade. He estimates the range to be 300 meters and

announces CHARGE ZERO to the assistant gunner. He checks to see that the firing selector is on lever fire and announces READY. The assistant gunner places a cartridge in the barrel. Upon releasing the cartridge, he immediately withdraws his hand to the rear and remains clear of the muzzle of the mortar until the cartridge has been discharged. The gunner alines the mortar barrel in the direction of the target, lowers or raises it until he has about 60° of elevation, and trips the firing lever. While waiting for the burst, the assistant gunner places another cartridge in the barrel.

(2) The first burst is slightly beyond the target and about 10 mils to the right. The gunner moves the barrel slightly to the left, raises it a small amount, and trips the firing lever. The second burst is effective and the gunner fires two more cartridges at the same direction and elevation to eliminate the enemy machinegun crew.

CHAPTER 9

FORWARD OBSERVER PROCEDURE

165. Target-Grid Method of Adjustment

a. Using the target-grid method of adjustment, anyone who has a means of communication with either an infantry or artillery FDC and who can read an azimuth can adjust fire on any target he can see. From the observer's viewpoint, this method is much simpler than previous methods because he does not have to know the location of the guns and he does not have to compute any data. It makes no difference how far he is off the gun-target line, because the FDC makes adjustments to keep the bursts on the observer-target line. To get fire on the target, the observer follows three simple steps.

(1) He establishes communication with an FDC.

(2) He reports the azimuth from his position to the target and attempts to locate the target for the FDC. To locate the target, he can use coordinates, the shift method, or any of the other methods that will inform the FDC where to fire the initial cartridge(s).

(3) If the initial round(s) misses the target, he sends corrections in meters to the FDC that will cause the subsequent round(s) to hit the target.

b. It is not necessary to be a trained FO or a communication expert to observe and adjust mortar or artillery fire. However, the adjustment of indirect fire is greatly facilitated by a knowledge of communication procedures and the methods of conducting fire explained in this chapter.

166. Advantages of Target-Grid Method of Adjustment

The target-grid method of adjustment has the following advantages:

a. The FO enjoys greater freedom of movement on the battlefield since he is no longer concerned with the location of the mortar and the MORT-TGT line. This enables him to accompany the rifle unit he is supporting, thereby giving it close and continuous fire support.

b. One observer can mass the fires of all mortar and artillery units within supporting range on a given target.

c. The combat soldier can fill any gaps in the forward observer's field of view, thus giving better indirect fire support to infantry units.

d. It simplifies the work of the observer and places the burden of computation on personnel of the FDC who can usually work under better conditions.

e. It eliminates the need for ranging rounds which can be back-plotted by the enemy to locate the gun positions.

f. It eliminates the necessity of training a large number of observers to compute correction factors and requires only relatively few trained computers at the FDC.

g. The system does not depend entirely on the accuracy of the observer's azimuth to the target. Errors as great as 100 mils can be made without having any appreciable effect on the adjustment. Larger errors throw the bursts off the observer-target line; however, such errors are easily detected by the computer and the correct azimuth can be quickly determined by connecting two on-line bursts on the plotting board and reading the azimuth of this line.

167. FO Procedure

a. When an FDC controls the fire of mortars emplaced in battery, any one of the forward observers can be used to adjust fire for the unit. Each observer is accompanied by a radiotelephone operator who carries and operates a voice radio. The observer also carries a telephone.

b. Each FO is assigned to observe and conduct fires for a particular rifle unit in the company sector or zone of action. He is also charged with

maintaining contact with the supported unit and keeping himself and the FDC completely informed of the tactical situation. His primary mission is to watch the movements of the supported unit and to adjust mortar fire on those targets interfering with the mission of that unit. He does this through observation and correction of prearranged fires and by adjusting fire on targets of opportunity which he observes or which are identified to him by others.

c. The relative position of the OT line with respect to the MORT–TGT line does not affect the observer procedure in the adjustment of observed fires. The observer makes his spottings and gives his corrections with respect to the OT line as described in paragraph 180. He determines errors in meters and sends corrections to the FDC. The FDC converts these corrections to appropriate fire commands. This is done by plotting the observer's corrections on a plotting board and determining graphically the deflection and range corrections so that the mortars can place the next burst at the point designated by the observer. If an observer becomes confused or forgets the steps in adjusting fire, he can ask FDC personnel for assistance. If necessary, the FDC can coach the observer through his adjustment step-by-step and bring fire upon the target. This is obviously a slow process. To assist in the reporting of targets, each FO may be given a freehand sketch or a suitable map showing the registration point and any other reference points whose chart locations are known at the FDC.

d. Terminology used by forward observers has been standardized throughout the Army, Navy, and Air Force. Therefore, the FO of a mortar section who is familiar with the basic principles of forward observer procedure is capable of adjusting the fire of any type of indirect fire weapon. To adjust the fire of indirect weapons of units outside his own company, he establishes communication with the firing unit and maintains it throughout the adjustment.

e. For a detailed study on forward observation and advanced techniques on the subject, see FM 6–40.

168. Methods of Locating Targets

The observer has five methods he may use to accomplish his mission of locating targets.

a. Shift. The observer frequently uses this method of reporting the location of a target. He gives the shift as a correction in meters, usually to the nearest 10 meters in deviation and 25 meters in range from the reference point specified in the third element of the call for fire. The shift from a reference point includes the following elements in sequence: DEVIATION, AND RANGE CORRECTION. The observer determines the shift as follows:

(1) *Deviation.* He measures the deviation in mils from the reference point to the target with binoculars, and estimates the distance to the reference point. Then he determines the correction in meters from the reference point to the OT line by use of the mil relation (or the deflection conversion table) and the observer-reference point distance. He includes the deviation correction in his call for fire; for example, FROM REFERENCE POINT, RIGHT (LEFT) (so many meters) (1 and 2, fig. 57).

(2) *Range.* The observer estimates the distance along the OT line to this target from the point where the perpendicular line from the reference point intersects the OT line. This distance is the range correction, and he includes it in the call for fire as ADD (DROP) (so many meters). (When designating targets for adjustment which are within 300 meters of friendly forward troops, he applies a 100-meter safety factor to the range correction. This safety factor is to allow for any possible error in range estimation that might cause the first round of the adjustment to fall among friendly troops.)

(3) *Accuracy.* This method gives accurate results for shifts of 40 mils or less and acceptable results for shifts up to 600 mils. For greater shifts in direction, the deviation error and the difficulty of estimating the distance to the intersection with the perpendicular increase rapidly. For this reason, the observer selects and adjusts on other registration points so that (the large) shifts to any likely targets can be kept to a minimum.

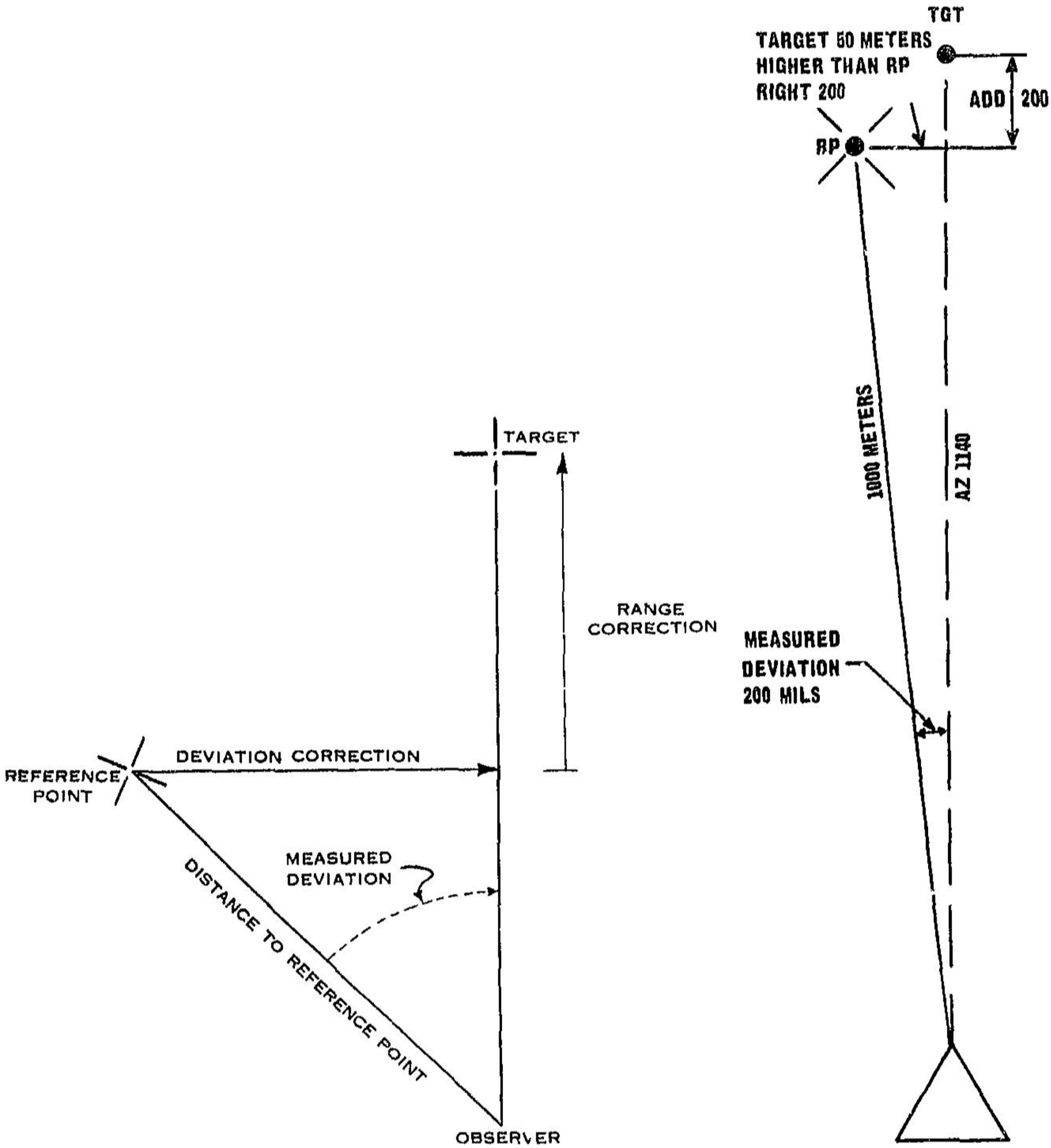


Figure 57. Determining deviation and range corrections, shifting from reference point.

(4) *Rapid plotting.* The observer may determine the shift from a reference point by using the plotting board for a rapid plot. The deviation in mils from the reference point to the target is measured with binoculars and distances to the reference point and to the target are estimated. This data is plotted on the plotting board and the initial shift in meters and the range correction are measured from the plot. When using the plotting board for this purpose, the center of the plotting board represents the observer's location.

b. Coordinates. The observer can use any grid system known to him and the FDC (fig. 58).

c. Polar Coordinates.

(1) When the observer's location is known by the FDC, the initial location of a target may be reported by polar coordinates (fig. 59). The FDC plots the target on the azimuth and at the distance from the observer's location as reported by the observer. This method is particularly desirable in the case of large lateral shifts and short observing (OT) distances. In locating the target by use of polar coordinates, the observer omits the third element of the call for fire (reference point or target coordinates) and in the fifth element (location of target-shift) informs the FDC of the range from his position to the target; for example, DISTANCE ONE FIVE HUNDRED. With this range and the observer-target azimuth (fourth element of the fire request) the FDC can plot the location of the target from the known location of the observer.

(2) The observer can determine his location in several ways. He may measure the azimuth to the firing position, a known point, or to a burst, and estimate the distance to same. The FDC then plots the observer's location on its firing chart (plotting board) according to this data. When he has a map, he sends the map coordinates of his location to the FDC. He may measure the azimuth to three (not less than two) points whose firing chart locations are known by the FDC or to two bursts. His location is then determined by resection.

d. Intersection. When the location of two observers is known by the FDC, the initial location of a target may be reported by intersection (fig. 60). The FDC plots the target by drawing the azimuth from the observers' locations as reported by the observers. These azimuths intersect each other at the location of the target. In locating the target by use of intersection, both observers must be able to see the target.

e. Marking Round. The observer may call a marking round from which he can shift to his target (fig. 61).

Examples: MARK HILL JC401
MARK REGISTRATION POINT
MARK REGISRATION POINT NUMBER THREE
MARK CENTER OF SECTOR
MARK TARGET NUMBER BK101

To help him identify the burst, the observer may call for a smoke round.

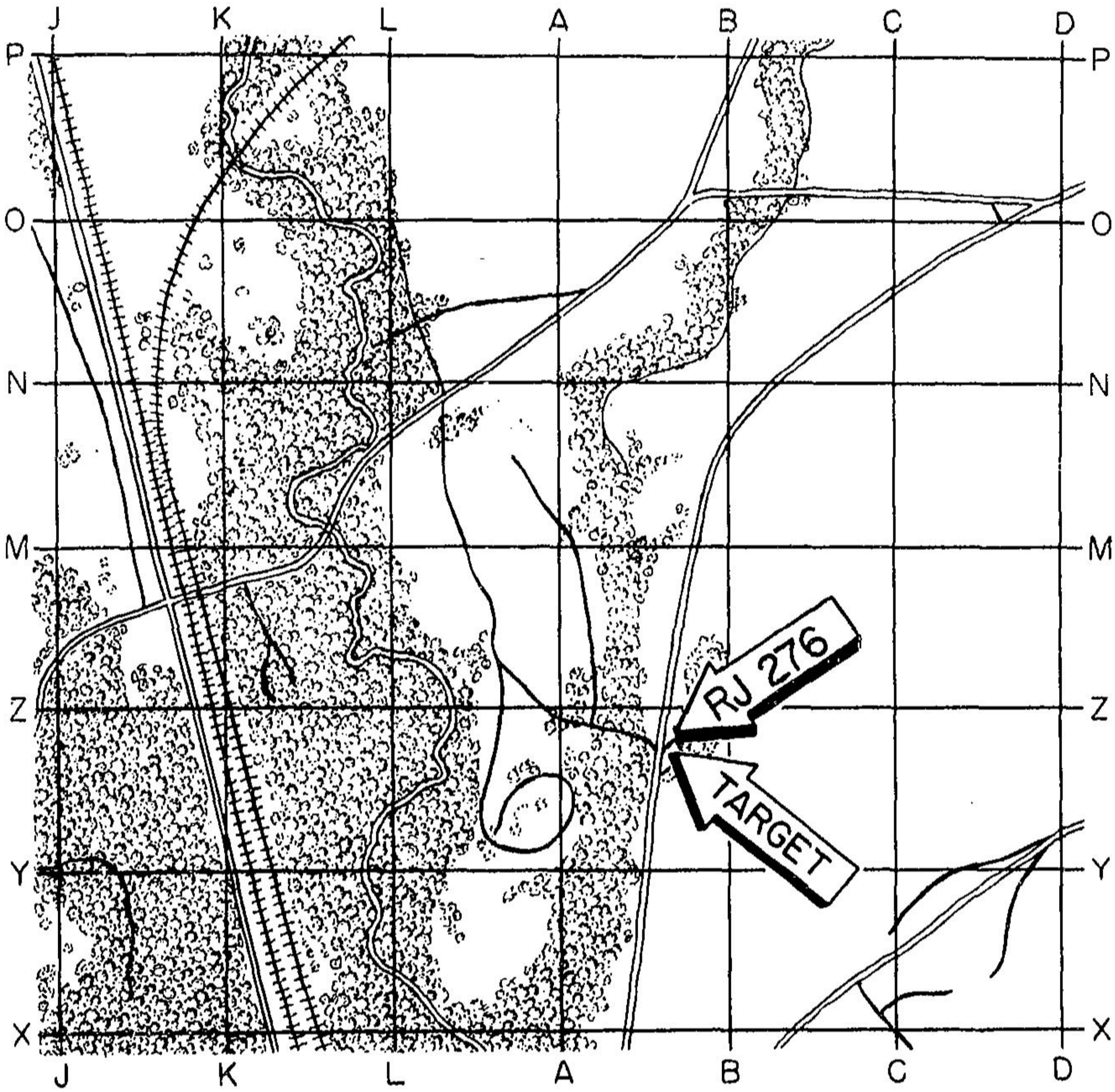
169. Call for Fire

a. The call for fire is a communication (fire message) sent by the FO to the FDC calling fire on a target. It is not a fire command. The call for fire sent by the FO includes those elements appropriate to the fire mission. The FDC may fire the called mission or it may decide that there are more important fire missions which should receive priority.

b. The same general sequence is employed by all indirect fire units that utilize the target-grid method of fire control. By following this sequence it is possible for the observer to obtain fire from any mortar or artillery unit with the least amount of confusion and in the shortest time.

c. The following elements are considered when calling a fire mission and are transmitted in the following sequence:

(1) Identification of observer.
(2) Warning order.
(3) Location of target.
  (*a*) Reference point or target coordinates.
  (*b*) OT azimuth (nearest 10 mils).
  (*c*) Shift.
(4) Description of target.
(5) Method of engagement (see note).
  (*a*) Type of adjustment.
  (*b*) Trajectory (omitted for mortar gunnery).



The observer sends the location of the road junction as
GRID ALFA YANKEE
SIX ZERO SEVEN ZERO

Figure 58. Designating the location of a target by grid coordinates.

(c) Ammunition.

1. Type of projec*ile.

2. Fuze action.

(d) Distribution of fire (see note).

(6) Method of fire and control.

Note. Used when adjusting naval gunfire.

Ommitted from normal call for fire (FM 6–40).

170. Identification of Observer

When necessary, the observer identifies himself to the unit from which he is calling fire, usually by use of a code word or an OP number.

171. Warning Order

The observer sends FIRE MISSION to alert the FDC. It indicates that call for fire follows.

172. Location of Target

The observer completes his location of the target in this element of the call for fire.

a. Reference Point or Target Coordinates. In this element, the observer partially or completely

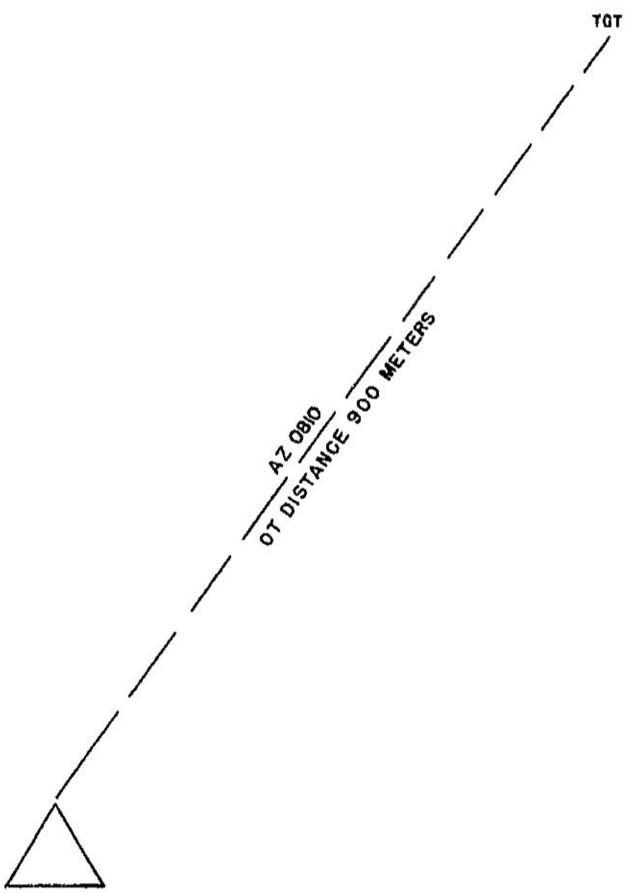


Figure 59. Locating a target by polar coordinates.

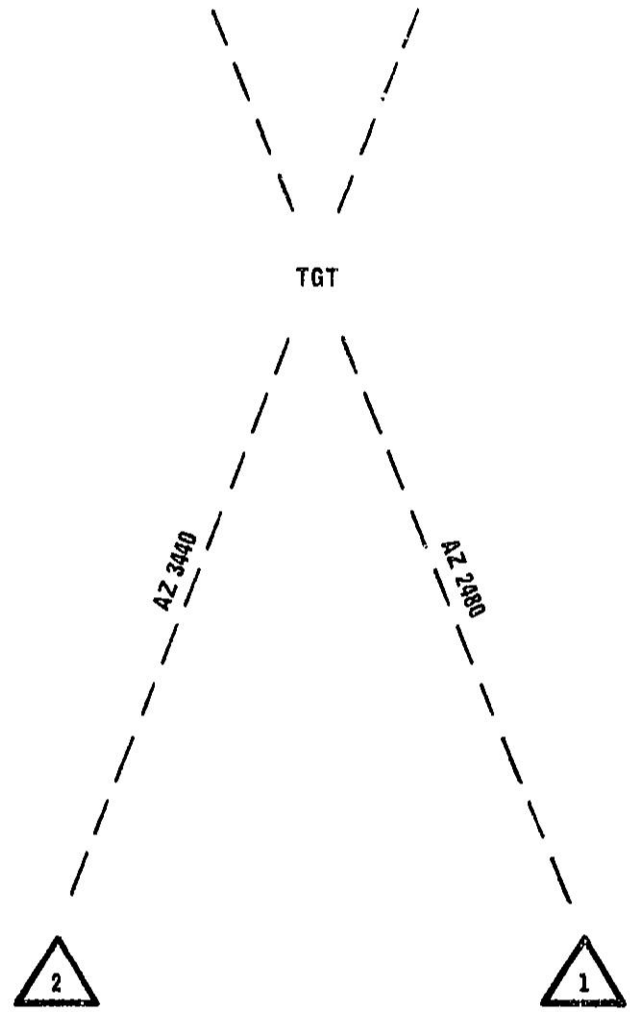


Figure 60. Locating a target by intersection.

locates the target for the FDC by using or providing a basis for one of the five methods of locating a target; for example, GRID ALFA YANKEE SIX ZERO SEVEN ZERO or FROM RP (as used in a shift).

b. Azimuth From Observer to Target. The observer determines the azimuth to the target from his position by use of a compass, other azimuth measuring instruments, or a map. To eliminate the necessity of taking a compass reading each time a target is to be engaged, he obtains accurate azimuth readings to the registration point and several other points well distributed in the target area. Then by measuring a deviation with his field glasses from one of these points and applying it to the known azimuth to that point, he can easily and quickly determine the azimuth to his target. For example, the azimuth to the regis-

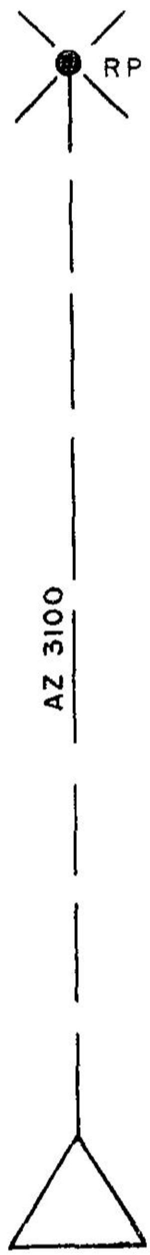


Figure 61. Locating a target using a marking round.

tration point from the observer's position has been measured with a compass and found to be 4,130 mils. A target appears 200 mils to the right of the registration point as measured in the field glasses. The azimuth to the new target is 4,330 (4,130+200). In the call for fire, the azimuth is announced as direction to the nearest 10 mils; for example, DIRECTION FOUR THREE THREE ZERO.

When no azimuth measuring instrument is available, the observer must estimate the azimuth. If the announced azimuth is greatly in error, the orientation of the plotting board is corrected at the FDC during the course of the adjustment. The observer must send the OT azimuth to the FDC for each fire mission he requests. It is along this azimuth that the FDC will plot all of the corrections and shifts which the observer transmits.

c. Shift. The observer may locate the target by a shift from a reference point, which may be the registration point, a numbered target, or any other point whose (chart) location is known at the FDC. It is here that he tells the FDC where he is shifting from; for example, LEFT FIVE ZERO, DROP ONE HUNDRED.

173. Description of Target

The description of the target is given as a description of the enemy installation, personnel, equipment, or activity which is observed. This description is brief, but informative enough to indicate to the FDC the relative importance of the target and the best manner of attack. When a screening mission or fire on a wide target is desired, the description includes the extent or width of the target. When zone fire is desired, the depth of the target is given. Information of an intelligence nature is reported promptly but does not delay fire missions.

174. Method of Engagement

When fires are classified as close, the creeping method of adjustment is used when they are within 300 meters of friendly troops. When fire is not close, it is classed as deep. Danger close is included in the call for fire, while deep is omitted.

a. Types of Adjustment. The type of adjustment is given only when the observer has special requirements or has information that will assist the FDC in firing the mission. This element may include—

(1) *Method of fire.* When the observer desires to adjust with a specific number of mortars, he specifies the desired number; for example, SECTION RIGHT, or NUMBER THREE.

(2) *Volume of fire.* The observer may indicate the desired volume of fire for effect; for example, SECTION: SIX ROUNDS, FIRE FOR EFFECT.

b. Trajectory. Omitted in mortar gunnery.

c. Types of Ammunition and Fuze Action. The observer may request the type of cartridge and fuze action desired. When no specific type of ammunition or fuze action is requested, the HE cartridge and superquick fuze are used.

d. Distribution of Fire. The observer may specify the type of sheaf he desires; for example, CONVERGE. Or he may give the extent of a special sheaf to fit a particular target.

175. Method of Fire and Control

The observer's designation of control consists of one of the following:

a. Adjust Fire. This indicates that the accuracy of the observer's location of the target is such that an adjustment is considered necessary, that the observer can adjust the fire, and that he will send corrections after each round, or volley. If observation is difficult or intermittent, the observer may send AT MY COMMAND, ADJUST FIRE. In this event, the observer transmits FIRE after receipt of READY from the FDC and when he is in a position to observe. This procedure remains in effect until a subsequent correction is followed by the command WHEN READY.

b. Fire for Effect. When transmitted as part of the call for fire, this indicates that the observer considers his location of the target to be accurate, no adjustment necessary, and surprise fire desirable.

c. Cannot Observe. This indicates that the observer is unable to adjust the fire, but that he has reason to believe that a target exists at the given location and that it is important enough to justify firing upon it without adjustment. The FDC makes the decision to fire the mission.

176. Examples of Call for Fires

a. Locating a target by use of a marking round (fig. 61).

OP ONE
FIRE MISSION
MARK CENTER OF SECTOR
DIRECTION THREE ONE HUNDRED
REGISTRATION
ADJUST FIRE

b. Locating a target by shifting from a reference point (fig. 57).

OP ONE
FIRE MISSION
FROM REGISTRATION POINT
DIRECTION ONE ONE FOUR ZERO
RIGHT TWO HUNDRED
ADD TWO HUNDRED
MACHINEGUN SECTION
FIRE FOR EFFECT

c. Locating a target by coordinates (fig. 58).

OP ONE
FIRE MISSION
GRID NINE SEVEN ZERO EIGHT THREE ZERO FIVE FOUR
DIRECTION ZERO EIGHT TWO ZERO
TROOPS IN FOXHOLES
SECTION RIGHT
AT MY COMMAND
ADJUST FIRE

d. Locating a target close to friendly troops by shifting from a reference point (fig. 62).

OP ONE
FIRE MISSION
FROM TARGET ALFA BRAVO SEVEN FIVE TWO
DIRECTION FOUR TWO SIX ZERO
LEFT ONE HUNDRED
DROP TWO HUNDRED
TROOPS IN OPEN EXTENDING RIGHT ONE HUNDRED AND LEFT ONE HUNDRED
DANGER CLOSE
ADJUST FIRE

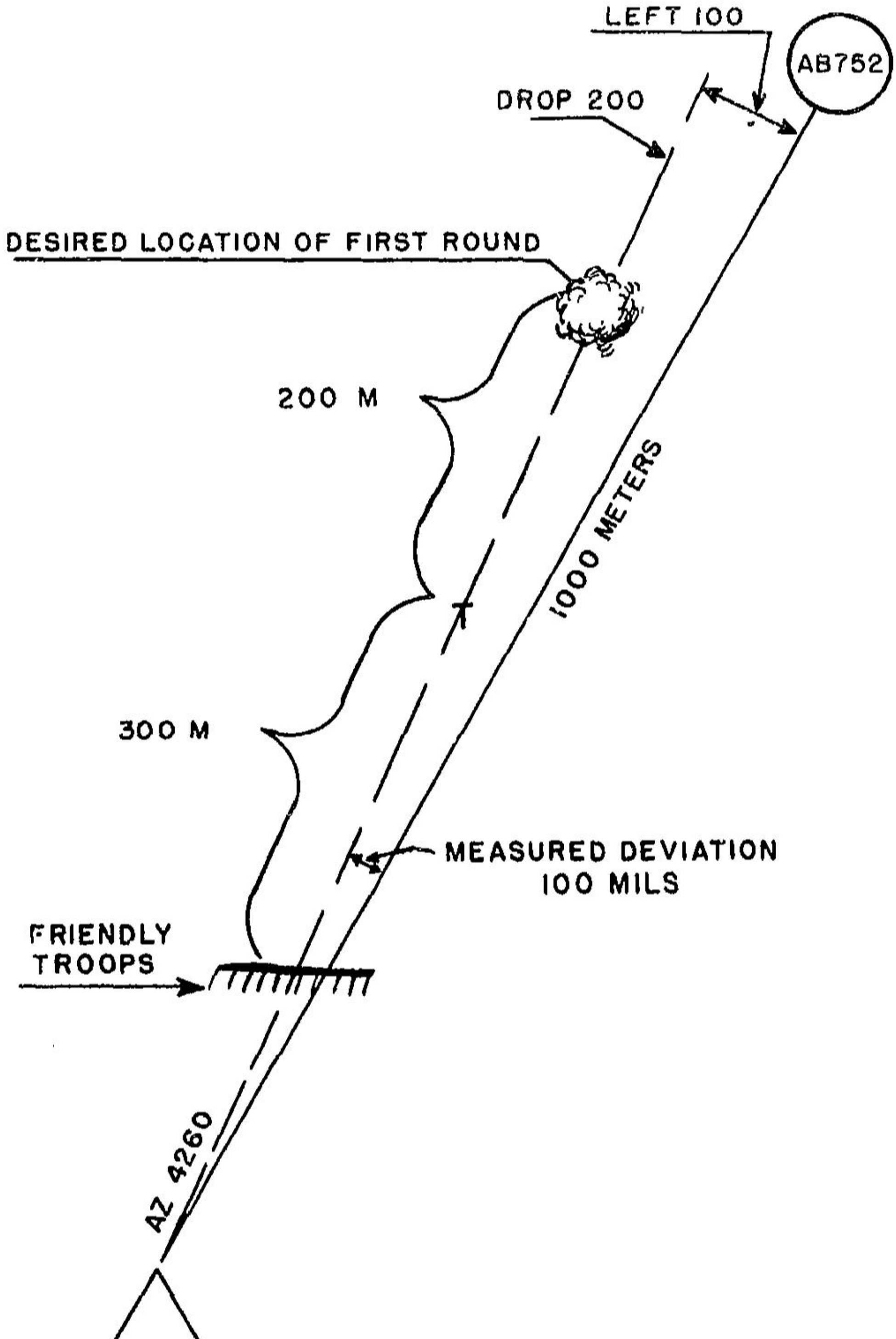
e. Locating a target to be screened.

OP ONE
FIRE MISSION
FROM REGISTRATION POINT
DIRECTION FOUR TWO HUNDRED
RIGHT TWO HUNDRED
ADD FOUR HUNDRED
DEFENSIVE POSITIONS
NUMBER ONE
WP
ADJUST FIRE

f. Locating a target by polar coordinates (fig. 59).

OP ONE
FIRE MISSION
DIRECTION TWO ONE EIGHT ZERO
OT DISTANCE NINE HUNDRED
ANTITANK GUN
ADJUST FIRE

Note. Observer's location is known by the FDC.



LOCATING TARGET CLOSE TO FRIENDLY TROOPS BY SHIFTING FROM A REFERENCE POINT

Figure 62. Locating a target close to friendly troops by shifting from a reference point.

177. Correcting Errors

When the observer finds that he has made an error in one of the elements of his call for fire, he sends CORRECTION, followed only by the information pertaining to the entire element in error. He does not retransmit the correct elements of his call for fire. If any element of the call has been omitted erroneously, he sends that element to the FDC as a separate transmission without repeating his entire call for fire.

178. Information Sent Observer

a. The FDC gives certain information to the observer to assist him in firing the mission. This information is informal in nature and the following sequence is given as a guide only:

(1) Adjusting mortar(s)	NUMBER TWO ADJUSTING
(2) Method of adjustment	ONE ROUND
(3) Cartridge and fuze	HE
(4) Time of opening fire	WHEN READY (when the mortar crew is ready)
(5) Mortars to fire for effect	SECTION
(6) Method of fire for effect	SIX ROUNDS
(7) Target number assigned	TARGET NUMBER NINE

b. The first four elements are given to the observer before the adjustment begins. The remaining elements are given before firing for effect.

c. When the FDC cannot fire a mission, it notifies the observer WILL NOT FIRE, and gives him the reason for not firing.

d. As each cartridge or volley is fired, the FDC informs the observer SHOT. The time of flight may be given the observer if an unabridged firing table is available in the FDC. As the unit starts fire for effect, the FDC informs the observer, for example, SECTION FIRING FOR EFFECT. When the observer has sent AT MY COMMAND, the FDC transmits READY to indicate that the mortars are ready to fire. They are fired upon receipt of FIRE from the observer. The FDC notifies the observer when all cartridges have been fired; for example, ROUNDS COMPLETE.

179. Corrections

a. General. Corrections are made in any firing data after an adjustment has started. The observer sends the corrections that he wants applied for the next firing. The corrections the observer sends to the FDC are based on his spotting of the previous round.

b. Subsequent Corrections.

(1) Subsequent corrections are transmitted to the FDC in the following sequence:

(*a*) Distribution (sheaf) correction.

(*b*) Change in any special requirements (for example, to change from single mortar to section fire during adjustment).

(*c*) Change in number of rounds to be fired.

(*d*) Change in ammunition (for example, to change from HE to smoke).

(*e*) Deviation correction (in meters).

(*f*) Height-of-burst correction.

(*g*) Range correction.

(*h*) Change in control.

(2) Terminology.

(*a*) Deviation corrections are sent to the FDC as RIGHT (LEFT) (so many meters).

(*b*) Height-of-burst corrections are sent to the FDC as UP (DOWN) (so many meters).

(*c*) Range corrections are sent to the FDC as ADD (DROP) (so many meters).

(3) The observer omits any element of the subsequent corrections, when no change in that element is desired. When some element is to be corrected, he sends the correction for that element. When he desires to fire with the same data as the last round, he requests REPEAT.

(4) The observer ends his subsequent corrections with a correction for range if there is one, except when a change in control is given. In this case, he gives a correction for range, followed by the method of fire and control, for example, ADD TWO FIVE, FIRE FOR EFFECT.

CHAPTER 10

CONDUCT OF FIRE ADJUSTMENT

180. General

In observed fire, the object of fire for adjustment is to determine from the observed bursts the firing data with which to fire for effect. The observer makes his spottings and determines his corrections with respect to the OT line. Due to the inability of the average FO to locate targets accurately for the FDC, and the dispersion inherent in mortars, a first cartridge hit on the target is not normal. The FO follows established principles in forward observation in adjusting on the target.

181. Fire Adjustment

a. The FO adjusts fire by the bracketing or creeping methods. He makes his spotting and gives his corrections with respect to the OT line. An off-line burst is brought to the OT line by applying a correction which is determined by multiplying the observed deviation in mils by the estimated OT distance in thousands of meters (the deflection conversion table may also be used to determine this correction) (para 132). The deviation correction in meters so determined is sent to the FDC as RIGHT (LEFT) (so much). Bursts are kept on the OT line graphically by the FDC. Range corrections in meters are sent to the FDC by the FO. Range corrections are determined along the OT line by seeking an initial range bracket and thereafter successively splitting the bracket until the correct range is determined.

b. Normally, fire is adjusted on a target before fire for effect is delivered. However, it is not always necessary to adjust fire on area targets which can be located accurately with reference to a point upon which an adjustment has previously been completed. As a general rule, new area targets which require a shift of less than 200 meters in range or deviation or both (from a reference point already adjusted upon), do not require a complete adjustment prior to fire for effect. When there is any doubt in the forward observer's mind as to his ability to locate accurately such a new target, he should adjust fire on it. An adjustment for a shift of less than 200 meters may consist of only a confirming round or section one cartridge. For shifts of greater than 200 meters, it is usually desirable to make a complete fire adjustment.

182. Spotting

a. General. A spotting is a mental process wherein the FO determines the location of the burst or group of bursts with respect to the target. The observer attempts to make positive spottings for range and deviation. He then uses this data to determine his correction. Spottings are divided into three categories: Range, deviation, and miscellaneous. The FO, in order to obtain positive spottings, must carefully study the terrain and take into consideration weather conditions, particularly wind and its effects on the burst. He must be trained to make positive spottings rapidly and accurately.

b. Range Spottings. There are five spottings for range—over, short, target, doubtful, and range correct. If the cartridge bursts between the target and observer, it is spotted as *short;* one which appears beyond the target is spotted as over. If the cartridge hits any portion of the target, it is spotted as *target.* A *range correct* spotting is obtained when the round is slightly left or right of the target and the observer determines that it is at the correct range. If the round is left or right and the observer cannot make a positive range spotting he spots the round as doubtful.

c. Deviation Spottings. There are three spottings for deviation—left, right, or line. When spotting for deviation, the observer measures the mil deviation using the horizontal mil scale of his binoculars. He makes his spotting and records it as right or left (so much). He makes no correction for a spotting of 10 mils or less unless this

deviation error persists throughout the adjustment (fig. 63).

Note. When instruments are not available, measure angles by the hand, fingers, mil scale alidade, or a ruler held a known distance from the eye. Determine the angle subtended by each before you go into the field. These angles may vary from the angles shown in figure 50.

d. Miscellaneous Spottings.

(1) If the FO has been adjusting fire on a given target and a round suddenly bursts out of the normal dispersion pattern, either for range or deviation, this round is spotted as *erratic*. An erratic round may be caused by faulty ammunition, errors within the FDC, or errors in laying the mortar. After spotting a round as erratic, the FO notifies the FDC so a check can be made to determine the cause before firing another cartridge.

(2) The FO may neither see nor hear the round that was fired. He may only hear the cartridge and might possibly make a positive spotting for range or deviation on this basis. When he cannot make a positive spotting, he spots the round as lost. In such cases he may either make a bold change or have the next cartridge fired with the same data.

183. Deviation Corrections

a. General. A deviation correction is the distance in meters required to move a subsequent burst, or the center of a subsequent group of bursts, right or left to place it on the OT line. The observer computes deviation corrections to the nearest 10 meters.

b. The OT Factor. The number expressing observer-to-target distance in thousands of meters is called the OT factor. The OT factor is carried out to one decimal place. An OT factor of 1.5 represents an OT distance of 1,500 (1,451 to 1,549) meters. OT distance can be measured on a map or estimated.

c. Computation of Deviation Correction. The observer uses the mil relation to compute a deviation correction. He multiplies the observed deviation spotting in mils by the OT factor to obtain the required correction in meters. This amount is rounded off to the nearest 10 meters. The correction is given in the direction opposite the spotting. Deviation correction is announced in meters as LEFT (RIGHT) (so much). The following are examples of computation of deviation corrections:

OT distance	*OT factor*	*Spotting*	*Deviation correction*
700 meters	.7	40R	LEFT 30
1,500 meters	1.5	50L	RIGHT 80
2,500 meters	2.5	100L	RIGHT 250
3,000 meters	3.0	20R	LEFT 60

d. Correcting Erroneous OT Factor. During the adjustment, the observer may find that his initial estimate of the OT distance was in error. In such a case, he must adjust his OT factor in accordance with a new estimate of the OT distance.

184. Bracketing

For the bracketing method of adjusting mortar fire with a fire direction center, see paragraph 157.

185. Adjustment of Fire Close to Friendly Troops

For the creeping method of adjusting mortar fire, see paragraph 158.

186. Adjustment of Sheaf

It may be necessary for the observer to adjust the sheaf of a section to correct for any errors made in laying the section parallel or to obtain a special sheaf. The front covered by any sheaf is the width of the sheaf plus the width of a burst. The types of sheaves which may be required to adjust are parallel and special. A special sheaf may be converged, open, or closed (fig. 64).

187. Parallel Sheaf

Following a registration, the FDC may tell the observer to adjust a parallel sheaf to correct for any errors made in laying the section parallel. Whenever possible, organic FO's are used to adjust a parallel sheaf. The sheaf adjustment is started after the correct range has been determined by the adjusting mortar. The FDC fires section right (left) and the observer sends individual corrections to place each burst approximately 30 meters apart. This gives a sheaf width of approximately 60 meters and a sheaf front of approximately 90 meters. (These figures are based on a normal section width of approximately 60 meters. If the section width is not approximately 60 meters, the FDC tells the observer to adjust a sheaf width equal to the section width.) The observer does not correct the range of individual bursts, but if necessary he corrects the range of the center of impact

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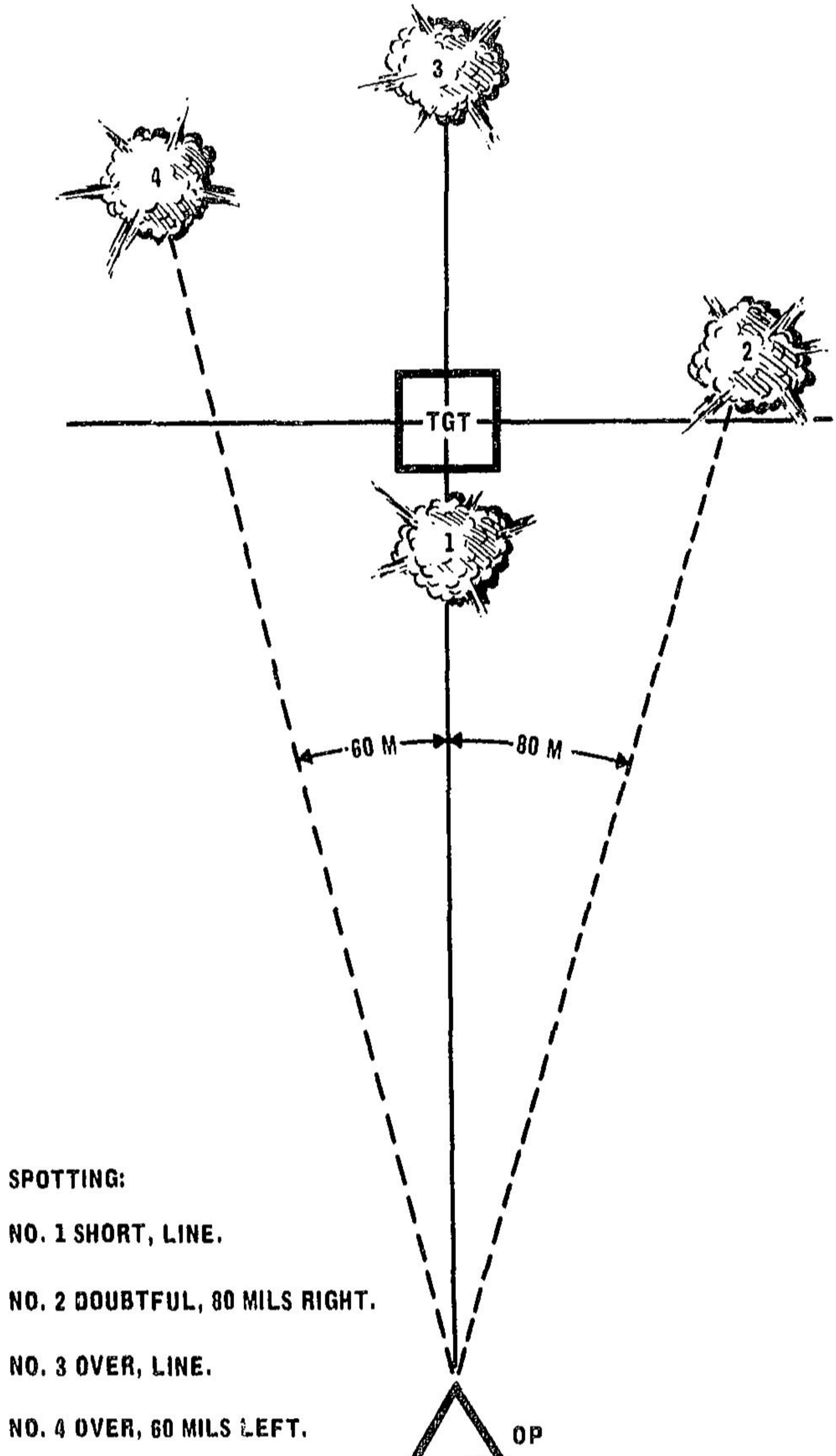


Figure 63. Spotting.

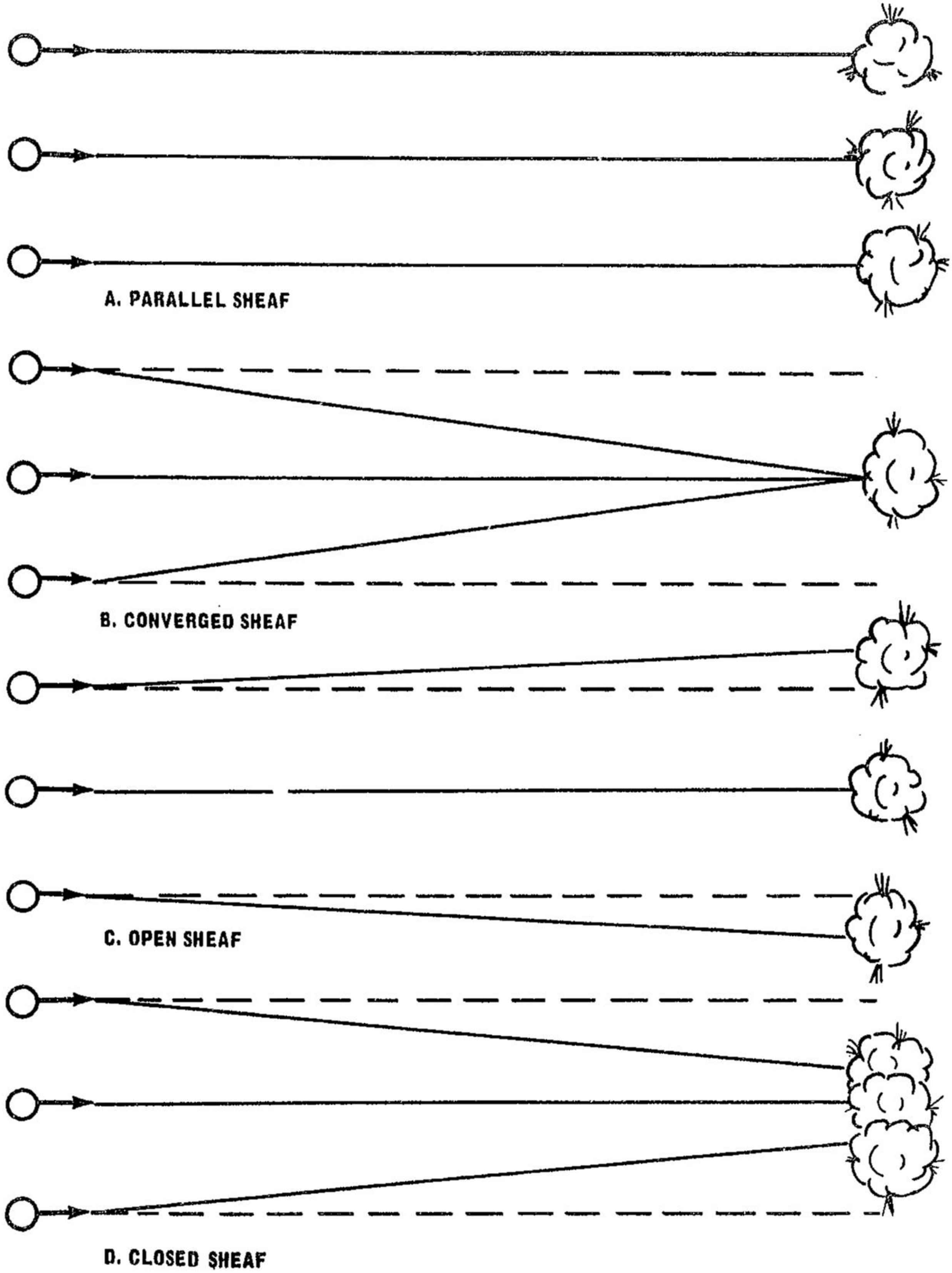


Figure 64. Types of sheaves.

of the section if in error. (The base mortar is adjusted on the registration point and the bursts of the other mortars are also adjusted with respect to the registration point.) The observer does this by determining the width in mils necessary between each burst using the mil formula: M equals W over R. When the sheaf is fired, he reads the deviation of each burst from the place where it should be; and using the mil formula again, he gives corrections in meters to place the burst in the proper position in the sheaf; for example, NUMBER ONE, RIGHT TWO ZERO: NUMBER THREE, LEFT THREE ZERO: END OF MISSION.

188. Special Sheaves

Fire for effect is normally delivered with a parallel sheaf. In situations where the FO calls for a special sheaf, the FDC makes the necessary computations and then fires for effect with the new data. When firing on targets of special shape, the observer may decide to request a confirming volley and correct the sheaf, if necessary, prior to firing for effect. When adjusting a sheaf of any type, the observer notes the direction of the wind and then requests the sheaf be fired from left or right so the rounds, as they burst, will not obscure the spottings of subsequent rounds.

189. FO Procedure in Use of Smoke

(fig. 65)

a. After careful evaluation of the terrain and weather, the observer locates a point on the ground where he wishes to place one flank of his screen. For example, if a flanking wind prevails, the observer normally locates the point of impact in front of the target and upwind. If necessary, the observer adjusts fire to determine the correct location of this point. For a screening mission, splitting a 100-meter bracket is normally sufficient. In the call for fire the observer should call for either No. 1 or No. 3 mortar as the adjusting mortar, depending on the direction of the wind. If a tailwind (a wind from 6 o'clock) or a headwind (a wind from 12 o'clock) prevails, the observer's choice for the adjusting mortar depends on the flank from which he desires to open the sheaf. An example of a screening mission call for fire is given in paragraph 176.

b. After the flank adjustment is completed, the observer calls that the sheaf be opened (right or left) to cover the target as desired and that a section (right or left) be fired. (An example of a subsequent correction to open the sheaf following the establishment of a 100-meter bracket is LEFT TWO ZERO, OPEN SHEAF LEFT (RIGHT) TWO HUNDRED METERS, SECTION LEFT (RIGHT), SMOKE, ADD FIVE ZERO.

Note. In section fire, the FDC will always fire SECTION RIGHT unless the observer specifies SECTION LEFT in his subsequent correction.

c. The observer uses these rounds to adjust the smoke on the area to be screened and to conform to the wind direction and velocity. The observer sends his corrections (in meters) to the FDC for each mortar which needs to be corrected; for example, NUMBER ONE, RIGHT FIVE ZERO. Based on the observer's corrections, the

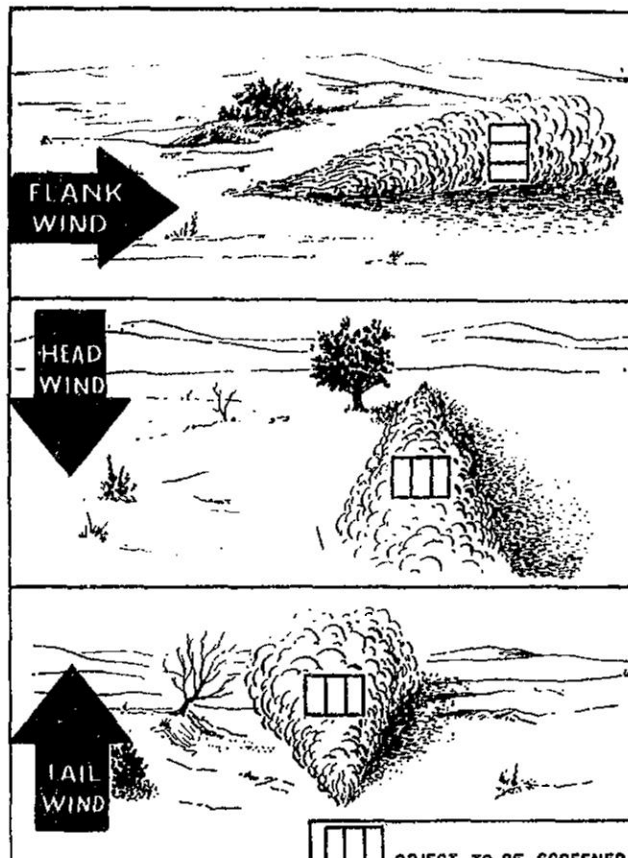


Figure 65. Smokescreen placement.

initial screen is established. The observer requests the necessary cartridges to maintain the screen and sends corrections to the FDC for individual mortars to fill in any gaps which occur. Based on the tactical requirements of the mission and the effectiveness of the screen, the observer may call for a certain rate of fire.

190. FO Procedure in Adjustment of Illumination

The point of burst of the illuminating round is placed so as to provide the maximum illumination of the target area in such a position that the final traverse of the flare is not between the observer and the target.

CHAPTER 11

FIRE DIRECTION CENTER PROCEDURE

Section I. ORGANIZATION AND FUNCTION OF FDC

191. Prearranged Fires

In the defense, detailed preparations can be made for the effective delivery of fire. Fires for which detailed and exact data are prepared beforehand are known as *prearranged fires*. In the attack, however, especially in a fast-moving situation, 60-mm mortars are limited in the amount of preparation possible.

192. Organization

a. The FDC enables the leader to control and quickly mass the fires of his entire unit. The FDC is located at or very near the firing positions so that fire commands may be transmitted to the mortar crew by voice.

b. Calls for fires are reported from all sources directly to the FDC where the targets are plotted *on the firing chart (M16 plotting board). From* this chart, firing data is prepared by the computer and announced to the mortar crews as fire commands. The FDC can be operated by the computer alone; however, it is desirable to include a radiotelephone operator so the computer can concentrate on his primary duties of computing firing data and issuing commands.

c. The term "Chief Computer" as used throughout this manual refers to the individual who is responsible to the commander for the conduct of the mortar section. He may be referred to as chief computer or section leader; the current TOE will designate his title.

193. General Duties of Personnel

a. Determine Mounting Azimuth. There are several ways of determining the mounting azimuth. The most generally used way is by a map. The computer or chief computer determines that location of the section on the map and then locates the registration point. In case the registration point cannot be readily identified on the map, he draws a line from the mortar location to the approximate center of the sector. By using a protractor, he can then determine the azimuth to the general area or exact location.

Note. When a plotting board is being used to control the fire of the mortars, they are mounted on the *closest 50-mil azimuth* to the azimuth actually determined.

For a detailed explanation of the methods of detemining the mounting azimuth, see paragraph 194. After the mounting azimuth has been established by one of the several methods, the squad leaders supervise the mounting of the mortars on the announced azimuth. The computer then determines the initial firing data.

b. Determine Initial Firing Data. Initial firing data consists of the deflection and range to fire the first cartridge in a registration, or the mark center of sector round. The deflection is determined by using the plotting board, based on the mounted azimuth. A range is determined which is sufficient to place the first round in a position in the target area where the observer can see it and begin his adjustment.

c. Enforce Priorities of Fire. In many cases, the commander (company or platoon) may assign priorities of fire for the rifle units of the company. The computer must be aware of the tactical situation and priorities of fire. He can then inform the observers whether or not their missions can be fired.

d. Determine Number of Mortars and Cartridges to be Fired. A target can be engaged with one mortar, two mortars, or three mortars. Then there is the question of how many cartridges the section must use to fire for effect. These decisions are made at the FDC, based upon the known tactical situation and the amount of ammunition available.

e. Compute Firing Data. One of the most important tasks of the FDC is to receive the observer's calls for fire and from these calls determine the firing data for the section, using the plotting board. This is usually the job of the computer, but he can be relieved in this capacity by the chief computer who would spell him in a round-the-clock operation.

f. Issue Fire Commands. From the data determined from the plotting board, the computer determines the fire command and issues it to the firing unit. The fire command relays pertinent information relative to the type of fire to be delivered and the direction, elevation, and charge to be used.

g. Maintain Firing Record. It is important for the FDC to record all firing data, for in many cases various targets are fired on again. If the firing data has been previously recorded, it will preclude the adjustment on targets already engaged. There is the possibility that a unit may be relieved on line. In such a case, the relieving unit will have a record of all targets in their sector of fire.

h. Maintain Ammunition Record. The FDC should be aware of the amount of ammunition the section has on hand so that it can determine how many cartridges to use in engaging a target. When it is evident to the chief computer or computer that the ammunition supply is low, a request can be made for resupply.

194. Determining Mounting Azimuth and Firing Data

a. General. The following information is needed in the preparation of initial firing data:

(1) Mounting azimuth. All azimuths used in mortar gunnery are normally grid azimuths. The use of grid azimuths facilitates the exchange of information between indirect fire units.

(2) Referred deflection.

(3) Initial deflection.

(4) Initial range.

b. Determining Mounting Azimuth. To protect the crew, the mortar is located in defilade. From this location, the gunner is not able to lay the vertical line of the sight directly on the target. Consequently, it becomes necessary to establish an aiming point to lay the mortar(s). The method selected to establish this aiming point depends on whether the leader who determines the mounting azimuth is on the line MORT–TGT or off to one side of this line. Several methods of determining the mounting azimuth are described in paragraphs 195 through 197.

195. Map Method

The mounting azimuth may be obtained from a map, a photomap, or an aerial photograph. First, locate both the mortar position and the target position on the map or photo. Next, draw a line between the mortar and the target. This is the MORT–TGT line.

a. When a protractor is used, extend the MORT–TGT line until it intersects a vertical grid line. Lay the protractor on the map or photomap with its index at this intersection and the straightedge along the vertical grid line. Read the azimuth from the mortar to the target. Then convert this map (grid) azimuth into a mounting azimuth and send it to the mortar position (fig. 66).

b. When a compass is used, orient the map or photo with the compass. Place the line of sight of the compass along the MORT–TGT line drawn on the map or photo. Then read the azimuth indicated by the compass index. This is the magnetic azimuth from the mortar to the target that is sent to the mortar position as the mounting azimuth (fig. 67).

c. When no north-south line has been placed on an aerial photograph, determine this line by first locating your position accurately on the photo. Then pick out some prominent terrain feature which can be located on both the ground and the photo. Draw a line on the photo from your location to the terrain feature. By use of a compass or an aiming circle, read the magnetic azimuth to the terrain feature. With the index of the protractor on the point which indicates your location on the photo, rotate the protractor around its index until the azimuth of the line of your position-terrain feature is indicated by its proper reading on the protractor scale. Without moving the protractor, draw a line along the straightedge of the protractor. This line is the magnetic north-south line of the aerial photo.

196. Azimuth Method

The leader uses this method when he cannot see the mortar position from his vantage point or observation post on or near the MORT–TGT line. He indicates the mortar position and moves to his vantage point or observation post. He is accom-

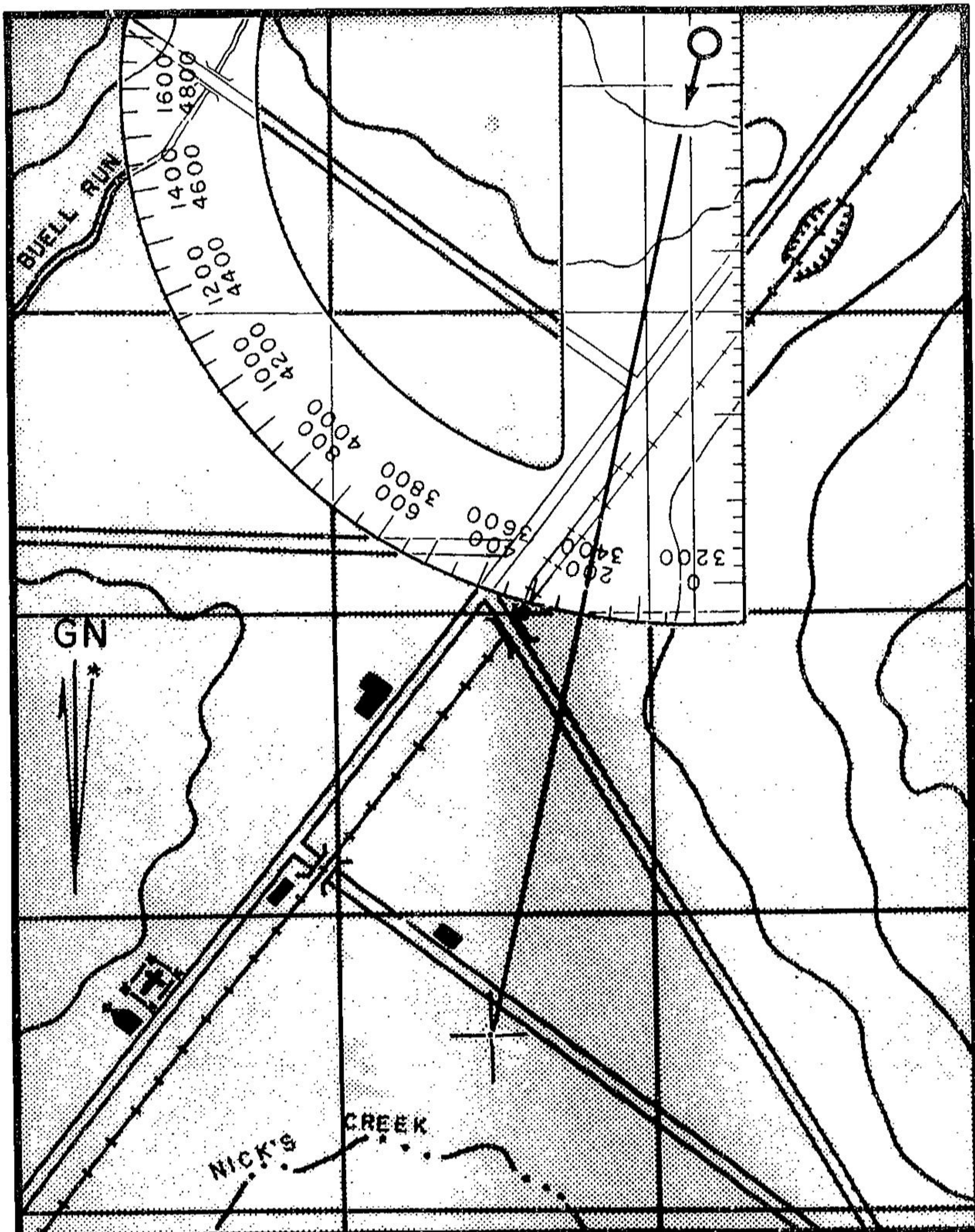


Figure 66. Map and protractor method.

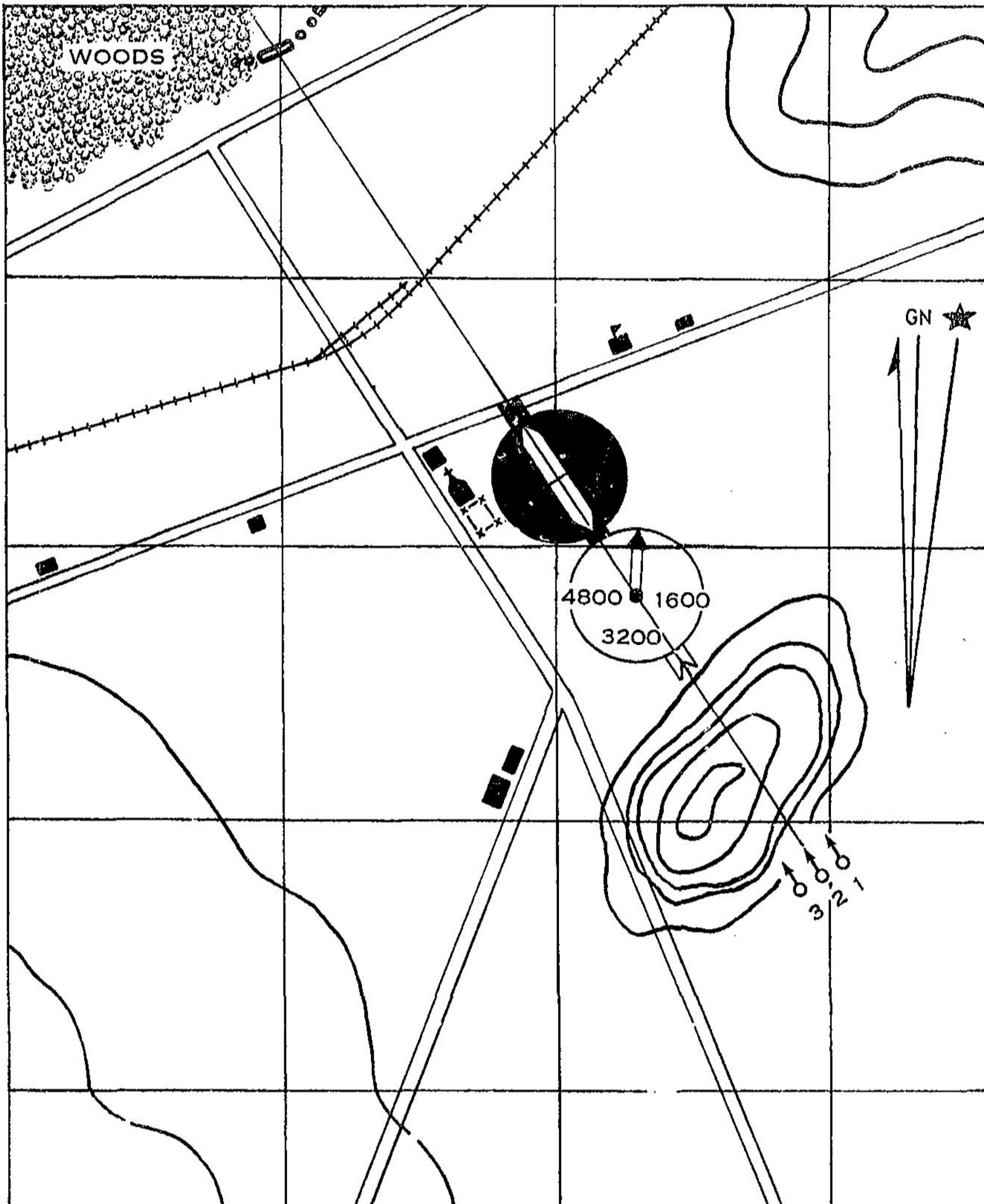


Figure 67. Map and compass method.

panied by a messenger. The leader places himself approximately on the MORT–TGT line (to aid in establishing this line, he selects a landmark at or near the mortar position before moving to his observation post) and reads the magnetic azimuth in mils to the target (fig. 68). He then sends the messenger back to the mortar position with a written notation of the azimuth. The gunner drives a stake to support the compass, lays off the recorded azimuth, and directs No. 2 to place an aiming post on the line of sight of the instrument. During the operation, the mortar and mount are removed at least 10 meters from the compass to reduce magnetic disturbance. The compass support stake can then be used as a baseplate stake to aline the baseplate for direction.

197. Direct Alinement

The leader indicates the approximate mortar position, moves forward to a point where he can see the target, places himself on the MORT–TGT line, and positions the M10 aiming post on this line. He turns the alidade until it forms a crosspiece on the aiming post and tightens the wingnut. He sights along the alidade, alining the straightedge on the target (fig. 69). Without disturbing the position of the alidade, he moves around the aiming post, sights back along the same straightedge to the mortar position, and directs that the baseplate stake be driven on this line to mark the location of the baseplate. The gunner drives the baseplate stake. No. 3 alines the sighting line of the baseplate on the line, baseplate stake—aiming post.

198. Plotting Board Method

The mounting azimuth can be determined graphically using the plotting board as indicated in paragraph 235.

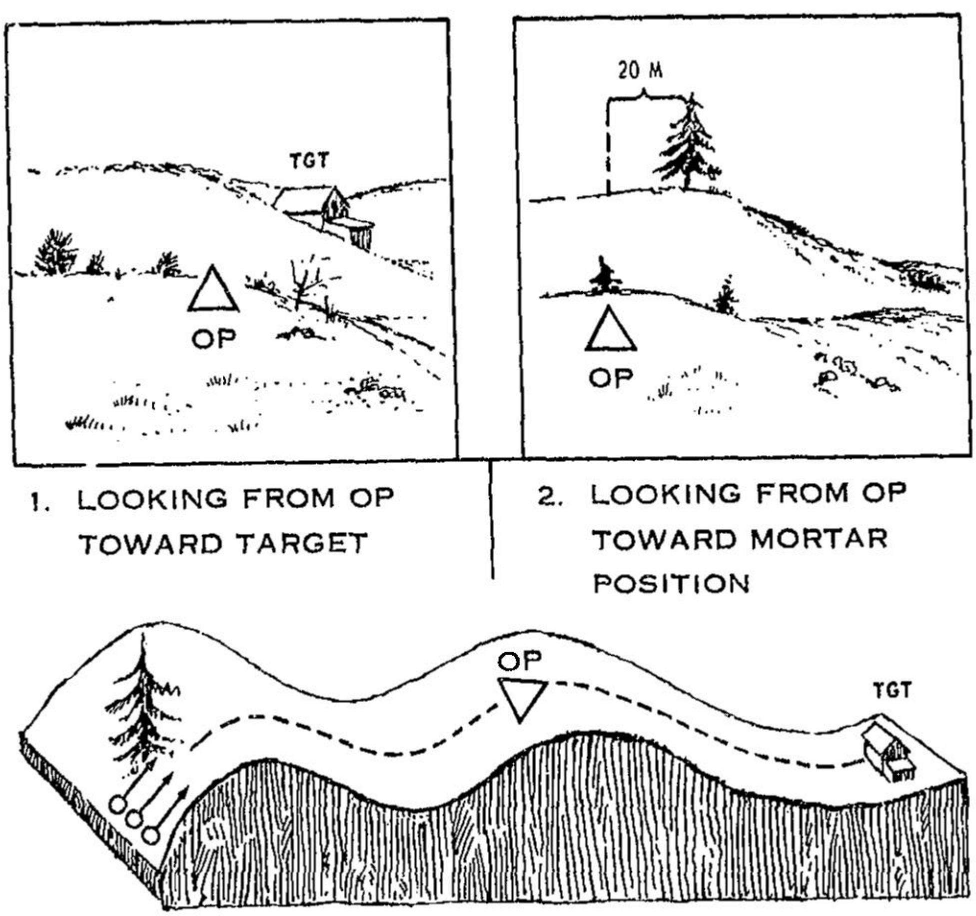


Figure 68. Azimuth method.

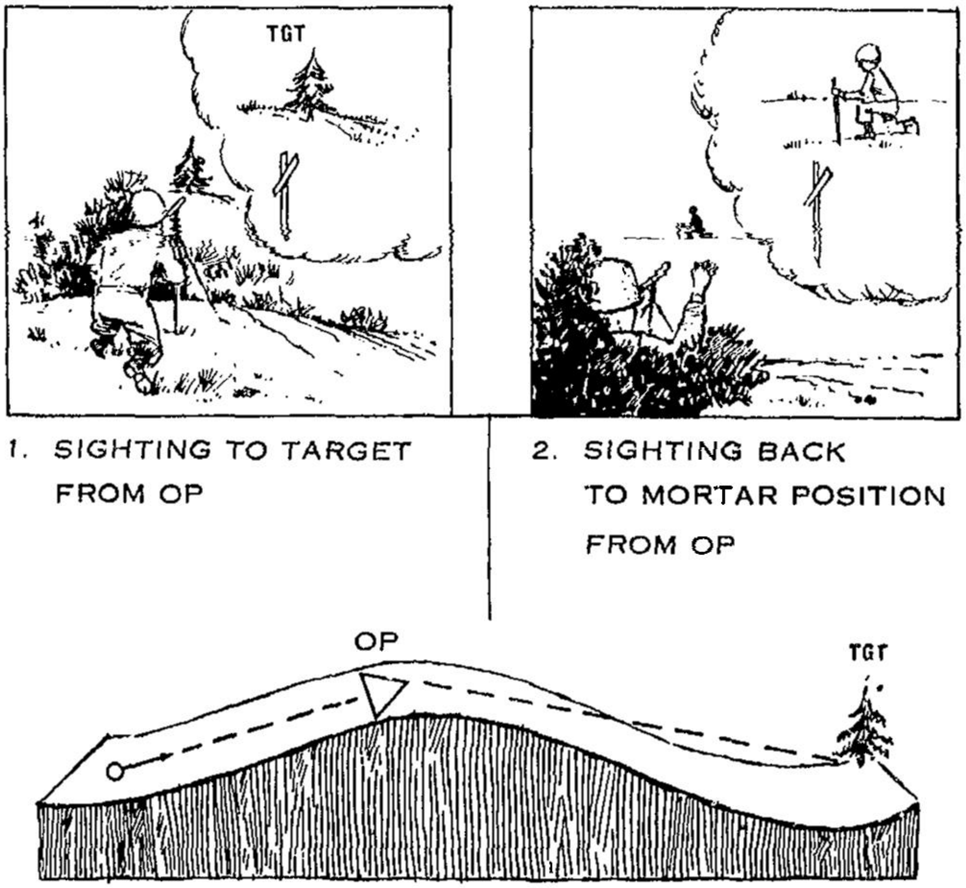


Figure 69. Direct alinement (aiming post) method.

199. Determining Initial Deflection When Mortar is Mounted

a. When mortars are already mounted and aiming posts placed out, initial deflection to new targets is determined as a deflection in mils with reference to the aiming posts established.

b. When a plotting board is being used to control the fires of the mortars, target-grid methods of fire control), the deflection to the new target is determined with reference to the aiming posts that have been placed out by the mortar crews in a direction specified by the FDC.

200. Determining Initial Range

a. Several methods of determining initial range are possible, with the choice of method to be used left to the leader determining the initial range. No matter what methods are used initially, it is usually necessary to determine the exact range by adjustment before firing for effect.

b. Initial range may be determined by—

(1) Estimation by eye.

(2) Plotting board (para 235).

(3) Map, photomap, or aerial photograph. Place the straightedge along the graphical scale of the map or photo and read the distance between the marks (between the mortar and the target).

(4) Field glasses and mil formula.

(*a*) Select at the same range as the target an object the width of which (in meters) is known or approximately known.

(*b*) Read the width of the object in mils with the field glasses.

(*c*) Knowing the width of the object in meters W, and the width of the object in mils M, solve the mil formula for R. The result is in thousands of meters.

(5) Intersection (para 232).

(6) Pacing.

(7) Taping or use of wire marked with tags or knotted at 50- or 100-meter intervals.

Note. The last two methods are normally used to determine distances such as from the OP to the mortar positions or from one mortar position to another.

201. No Immediate Target

When there is no target to be engaged immediately, an azimuth from the mortar position to a registration point or center of the unit sector is determined and the mortars are mounted on this azimuth. Firing data is then determined to register the mortars on the registration point. When registration is complete, both the FDC and forward observer have a common point of reference. It is possible to shift from the registration point (common point of reference) and engage other targets throughout the unit sector.

202. Firing Data

The information necessary to point (lay) mortars is termed *firing data* and includes direction, distribution, and range. This data may be obtained by computation, estimation, or graphical means based on locations obtained by observation or by map or photographic analysis. The computer converts firing data to fire commands, which are transmitted to the mortars. All numbers given in fire commands and FDC commands are repeated digit-by-digit except when they are in even hundreds or thousands.

203. FDC Command

The *fire direction center command* contains the information, usually delivered *informally* by the chief computer to the computer, which the computer must have to compute the firing data to be placed on the mortars.

204. Fire Commands

a. Origin. Fire commands originate with the computer at the FDC, or when mortars are employed without an FDC, with the leader at the observation post. These commands contain the technical instructions which enable the gunners to lay the mortars for elevation and direction.

b. Transmission. It is often desirable to issue fire commands in fragmentary form as the elements of the command are determined. When issued in this manner, the command can be executed while it is being issued. Whenever practicable, fire commands are given orally. When voice commands are not practicable, telephone, radio, or arm-and-hand signals may be used. The gunners repeat the elements of every fire command as they receive them.

c. Types. Fire commands are of two types—*Initial fire commands* and *subsequent fire commands.* The elements of both follow a definite sequence. However, subsequent commands include such elements as are changed, except that elevation is always announced.

205. Initial Fire Commands

Initial fire commands contain the necessary data to lay the mortars and fire the first round. The sequence for transmission of the initial fire command is—

a. Mortars to follow commands.
b. Cartridge and fuze.
c. Mortars to fire.
d. Method of fire.
e. Deflection.
f. Charge.
g. Time setting.
h. Elevation.

206. Elements of Initial Fire Commands

a. Mortars to Follow Commands. This element serves two purposes—it alerts the firing unit, and it designates those weapons of the firing unit which will execute all but the loading and firing instructions. An example of this element is SECTION. The command for a single mortar or a combination of mortars is NUMBER ONE or SECTION. This element definitely establishes which pieces of the firing unit will follow the command.

b. Cartridge and Fuze. The type of round is determined by the FDC with regard to the call for fire from the FO and the amount and type of ammunition available, as HE QUICK, WP, or ILLUMINATING.

Note. Elevations and charges used in this manual are based on round, HEQ, M49A2.

c. Mortars to Fire. This element designates the specific mortar or mortars which will fire. The command to fire a single mortar is NUMBER TWO, NUMBER ONE, etc. This element is omitted if the mortar or mortars to fire are the same as those announced in the first element (mortars to follow).

d. Method of Fire. Mortars designated to fire are notified as to the number of rounds that will be used and special instructions as to manipulation

or control required by the FDC. Examples of methods of fire are—

(1) Volley fire, when each designated mortar fires the specified number of rounds as rapidly as consistent with accuracy without regard to other mortars; for example, FIVE ROUNDS or FIVE ROUNDS AT MY COMMAND.

(2) Section fire, when mortars are fired successively from a designated flank at regular intervals (normally 10 seconds); for example, SECTION RIGHT (LEFT) ONE ROUND.

(3) Continuous fire, when a series of sections are desired; for example, CONTINUOUS FIRE FROM THE RIGHT AT TWENTY SECONDS.

(4) Searching fire, when a target in depth is engaged; for example, FIVE ROUNDS, SEARCH UP TWO TURNS.

(5) Traversing fire, when a target in width is engaged; for example, FOUR ROUNDS, TRAVERSE RIGHT THREE TURNS, AT MY COMMAND.

e. Deflection. The FDC designates direction by announcing the deflection to be placed on the sight; for example, DEFLECTION TWO EIGHT EIGHT ZERO.

f. Charge. A charge consistent with the required elevation is announced; for example, CHARGE TWO.

g. Elevation. The FDC announces the elevation to be placed on the sight as obtained from the firing table; for example, ELEVATION ONE TWO THREE ONE. Note that the FDC does not announce a control element at the end of the fire command. The elevation element is the command to fire unless the FDC specified otherwise in the *method of fire* element.

207. Examples of Initial Fire Commands

a. For a section (base mortar conducting adjustment when ready, section to fire for effect)—

SECTION
HE QUICK
NUMBER TWO
ONE ROUND
DEFLECTION TWO SEVEN FOUR FIVE
CHARGE THREE
ELEVATION ONE ONE EIGHT SEVEN

b. When the section is ready to fire, the section leader notifies the FDC that the section is UP. The FDC then commands FIRE.

208. Subsequent Fire Commands

a. General. Subsequent fire commands include only such elements as are changed, except that the elevation is always announced.

b. Corrections in Deflection. Corrections in deflections are given in mils—DEFLECTION TWO EIGHT EIGHT FIVE; DEFLECTION TWO SIX FOUR ZERO, etc. When the deflection is correct, this element is omitted in the subsequent fire command. The exact deflection to be placed on the sight is announced each time the deflection element is given.

c. Corrections in Elevation. This element is always included in the subsequent fire command. The elevation is given in mils—ELEVATION ONE TWO THREE ONE. When the elevation element is unchanged, repeat the announced elevation.

d. Cease Firing and Suspend Firing.

(1) CEASE FIRING is announced when a fire mission is completed. It indicates that the mortar crew will remain on the alert and that additional instructions are to follow. Firing is renewed by announcing a new fire command.

(2) SUSPEND FIRING indicates a temporary cessation of firing and allows firing to be resumed with the same data by use of the command RESUME FIRING, or by a subsequent command.

e. End of Alert. The end of the alert is announced as END OF MISSION. This allows the mortar crew to relax between fire missions. The gunner automatically lays on the center of sector with an elevation of 1100 mils or, in defensive situations, lays with the deflection and elevation for the final protective fires.

209. Examples of Subsequent Fire Commands

a. For the adjusting mortar of a section—

DEFLECTION TWO SEVEN SIX ZERO
ELEVATION ONE ONE EIGHT TWO

b. For a section (base mortar has completed adjustment and the FDC wants the section to fire for effect when ready)—

SECTION
FIVE ROUNDS

DEFLECTION TWO SEVEN FOUR ZERO
ELEVATION ONE ONE EIGHT TWO

210. Repeating and Correcting Commands

a. Repeating Commands. When the gunner fails to understand any element of the fire command, he may request a repetition of that element by announcing: SAY AGAIN THE DEFLECTION (ELEVATION). When any crewmember asks that any element be repeated, misunderstanding is avoided by prefacing the repeated element with the phrase THE COMMAND WAS________.

b. Corrections.

(1) *Initial fire command.* When the computer has issued his initial fire command to the gunners and finds that he has made an error in one of the elements, he sends CORRECTION, followed *only* by the information pertaining to the entire element in error. The remaining elements of the initial fire command need not be reissued.

(2) *Subsequent fire commands.* When the computer issues erroneous data in the subsequent commands, he corrects it by saying CORRECTION, followed by the entire corrected command. The word "correction" in this case cancels the entire subsequent fire command.

211. Firing Data Records

Firing data records are maintained by the computer and consist of the computer's sheet (DA Form 2399–R) (fig. 53, FM 23–90) and DA Form 2188–R (Firing Data Sheet) (fig. 70) which will be reproduced locally on 10½ by 8 inch paper.

a. The DA Form 2399–R is used to record—

(1) The call for fire or the FDC command.

(2) Subsequent corrections reported to the FDC.

(3) The fire commands announced to the firing mortars.

(4) Adjusted data.

(5) Firing corrections (if any).

(6) Data for replot (applicable only when firing corrections have been determined).

(7) The amount of ammunition expended.

b. When no firing corrections have been determined, the firing correction and data for replot are disregarded on the DA Form 2399–R. When no firing correction has been determined, the adjusted data and data for replot are the same. The computer uses one DA Form 2399–R for each new fire mission. He may destroy this form after completing the fire mission, transferring the pertinent data to the firing chart and the DA Form 2188–R.

c. The computer records the firing data on a DA Form 2188–R for the targets that have been fired on. He uses it in conjunction with the plotting board so that he does not have to include the detailed information for each target on the plotting board. After a mission has been fired, he records the following on the DA Form 2188–R: target number (or final protective fire number), MORT–TGT range, MORT–TGT azimuth, description, total deflection from registration point, direction (deflection and aiming point), elevation and charge, and firing corrections determined after reregistration. For prearranged fires, he includes the mortars to fire and methods of fire.

212. Operation of FDC for Larger Indirect Fire Weapons

For a study of the operation of FDCs of the larger indirect fire weapons, to include 4.2-inch mortars and large caliber artillery, see FM 23–90, FM 23–92, and FM 6–40.

FIRING DATA SHEET (FM 23-90)				DATE 1 Nov 66
ORGANIZATION Co. A	LOCATION MAP 1/25,000 Cor4561278921		MOUNTED AZIMUTH 1200 ₥	REFERRED DEFLECTION 2800 ₥
FIRING CORRECTION: DEFLECTION — RANGE —				

TGT NO.	DESCRIPTION AND COORDINATES	CARTRIDGE AND FUZE	MORTARS FIRED	METHOD OF FIRE	DEFLECTION	RANGE	CH	TIME SETTING	ELEVATION
REG	REG-(1864. 7521)	HEQ. M52	SEC	3 RDS	2835	1375	2		1009
AB750	PLT DIG IN(18957518)	HE, TSQ 77	SEC	10 RDS	2902	1400	3		1214
AB751	MG SEC-(19017410)	HEQ M52	SEC	5 RDS	2765	1325	2		1049
AB752	MORTAR SEC.-(20127531)	M362, PROX	SEC	5 RDS	2890	1600	3		1111
AB753	SQD IN OPEN-(2205-7420)	HEQ, M52	SEC	6 RDS	3020	1200	2		1110
AB754	PLT IN OPEN-(1975-7310)	M362, PROX	SEC	10 RDS	2470	2200	5		1169
AB755	CO. IN OPEN(18707550)	M362, PROX	SEC	15 RDS	2745	3000	6		1043

DA Form 2188-R, 1 NOV 58 REPLACES DA AGO FORM R-5656, 1 MAR 51

Figure 70. Suggested firing data sheet.

Section II. M10 AND M17 PLOTTING BOARDS

213. General

The M10 and M17 plotting boards are fire-control instruments designed to help the operator in computing and plotting firing data. They consist of a transparent, rotatable disk attached to a flat base (fig. 71). They are sturdy, simple to operate, accurate, and easily adapted to use in the field. They are carried in a durable canvas case.

a. Base.

(1) The base (fig. 72) is square on one side and semicircular on the other. Printed on the base and directly under the disk is a circular area marked with a rectangular grid printed in red (green with the M17). Note the *red* base *index line with the arrow*. This index line is graduated outward from the center (pivot point) from 0 to 20 in hundreds of meters. These numbers are spaced at every second horizontal fine line. Each small grid square is, therefore, 50 meters on a side. To the left of the index line are figures giving double values for the grid squares. At this scale, each small grid scale is 100 meters on a side. However, *any value may be assigned to the small grid square which best suits the problem at hand.*

(2) The red arrow of the base index line points to a red "0" and a fine red line which extends to the edge of the plotting board (through the center of the vernier scale). This fine red line is the *index mark* on the base *at which all deflections or azimuths are read*. The base is oriented when the *red arrow* of the index line is at the top (pointing away from the oper-

ator) and the square side is to the operator's right. The pivot point, designated by the letters OP, represents the location of the observation post, or of a firing position, as desired.

(3) Besides the grid scales, there are printed on the base three scales for measuring and a vernier scale for greater accuracy in using the mil scale on the disk. These scales are—

(*a*) At the bottom of the base is a *triple map scale* in yards (meters with the M17) with its legend above it, with representative fractions of 1/50,000: 1/25,000; and 1/5,000. These representative fractions refer respectively to the top, middle, and lower scales. Use these scales to transfer data to or from a map or firing chart which has one of these scales.

(*b*) At the right side is a *scale of inches* in 10ths, numbered from 0 to 7 inches and having an extension divided into 20ths.

(*c*) At the top is a *scale in centimeters*, divided into millimeters, and numbered from 1 to 9.

(*d*) Opposite the red arrow of the index line is a *vernier scale* for use with the mil scale on the disk. This scale is helpful in reading azimuths accurately to one mil, when the *index* on the base is not directly under one of the graduations on the mil scale.

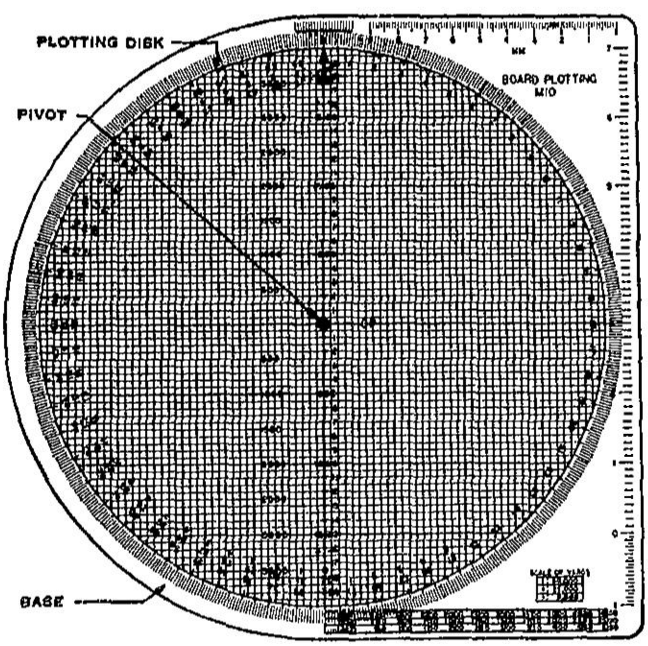


Figure 71. M10 plotting board.

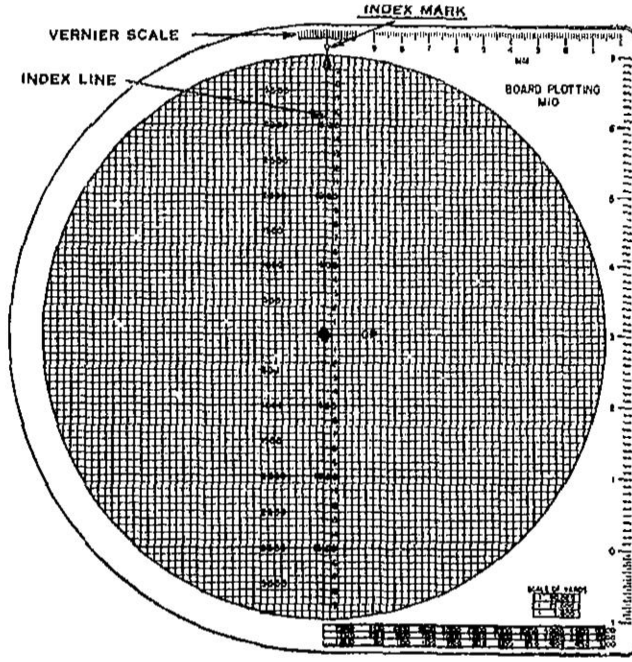


Figure 72. Base.

b. Plotting Disk. The disk (fig. 73) is made of a plastic material which is roughened on the upper surface to receive pencil marks. Four scales and a fine black line are printed on the disk as follows:

(1) A complete mil scale (referred to later as the mil scale) is printed in black, running around the outer edge in a clockwise direction to conform to the compass for plotting azimuth angles. This scale is divided in 10-mil increments and numbered in hundreds of mils from 0 to 6400.

(2) A supplementary scale (the middle scale) is printed in red, running counterclockwise from 0 to 3200 and 3200 to 500. This middle scale is numbered in hundreds of mils. It is used in computing angles of site for weapons other than mortars.

(3) A second supplementary mil scale (the inner scale) is printed in black and runs clockwise. The 0 of this scale appears under the 3200 on the *mil scale*. This scale is numbered in hundreds of mils from 0 to 3200. It is used in computing angles of site for weapons other than mortars.

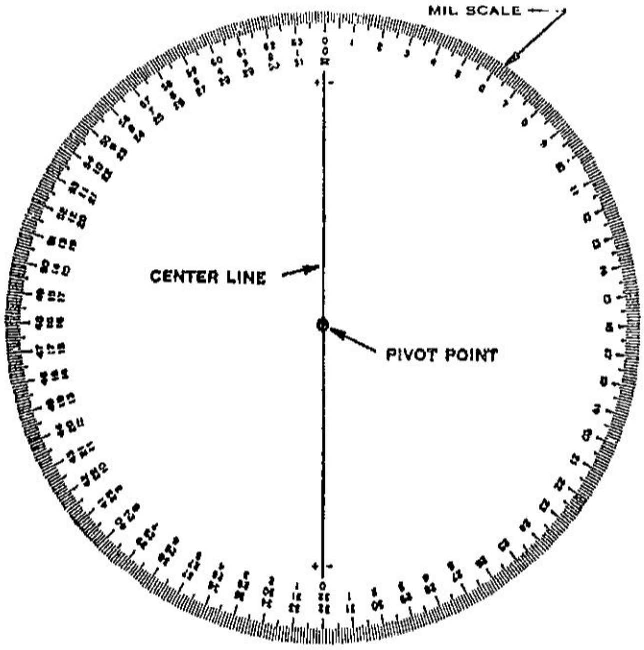


Figure 73. Rotatable plotting disk.

(4) A fine black line, referred to as the centerline, is printed across the diameter of the disk from 0 to 3200 on the mil scale. Plus and minus signs are printed in red at both ends of this centerline for use in computing angles of site for weapons other than mortars.

214. Care and Preservation

a. In handling the plotting board, be careful to avoid bending, scratching, or chipping it. Do not use pencils harder than 2H or gritty erasers on the transparent plotting surface.

b. To clean the disk or base, wipe with lens tissue paper (or soft cloth) moistened with lens-cleaning liquid soap. When clean, dry carefully by gently rubbing with lens tissue paper (or soft cloth). *Do not clean the disk or the base with gasoline, drycleaning solvent, alcohol, acetone, or other solvents.*

Section III. M16 PLOTTING BOARD

215. General

The M16 plotting board is a fire control instrument designed to assist the operator in computing firing data by providing the range and direction from the mortar position to the target. It is sturdy, easy to operate, accurate, and suitable for use in the field under adverse atmospheric conditions. It is carried in a durable nylon case (fig. 74). Throughout this chapter, the M16 plotting board may be referred to as a "firing chart" or a "board."

216. Description of M16 Plotting Board

The plotting board consists of a pivoted disk of transparent plastic and a removable range arm attached to a flat base.

a. Base. The base is a white plastic sheet securely bonded to a magnesium alloy backing (fig. 75). On the base is a rectangular grid printed in red, at a scale of 1: 12,500. Note the red base *index line with the arrow.* This index line is graduated and numbered outward from the center (pivot point) from 0 to 31 in hundreds of meters. The numbers are spaced every second fine horizontal line. Each small grid square represents 50 meters on a side. To the left of the index line are figures giving the same 1: 12,500-meter scale numbered from the bottom of the base each 500 meters from 0 to 6,000 inclusive. This scale facilitates range determination when the mortars are plotted below the pivot point.

(1) The red arrow of the base index line points to a fine black line extending through the center of the vernier scale to the edge of the plotting board. This line is the index on the base *at which deflections or azimuths may be read.* The operating position of the board is with the *red arrow* of the index line at the top of the board and the straight side of the base to the operator's right. The pivot point represents the location of the firing position when using the range arm.

(2) In addition to the grid pattern, a vernier scale is printed on the base. It is used to obtain greater accuracy when reading the mil scale on the disk. The vernier scale permits the operator to read azimuths accurately to the nearest 1 mile when the index mark is between one of the 10-mil graduations on the scale of the disk.

(3) On the straightedge of the base, a double map scale in meters with representative fractions of 1: 50,000 and 1: 25,000 is available for use in transferring data to and from a map that has one of these scales.

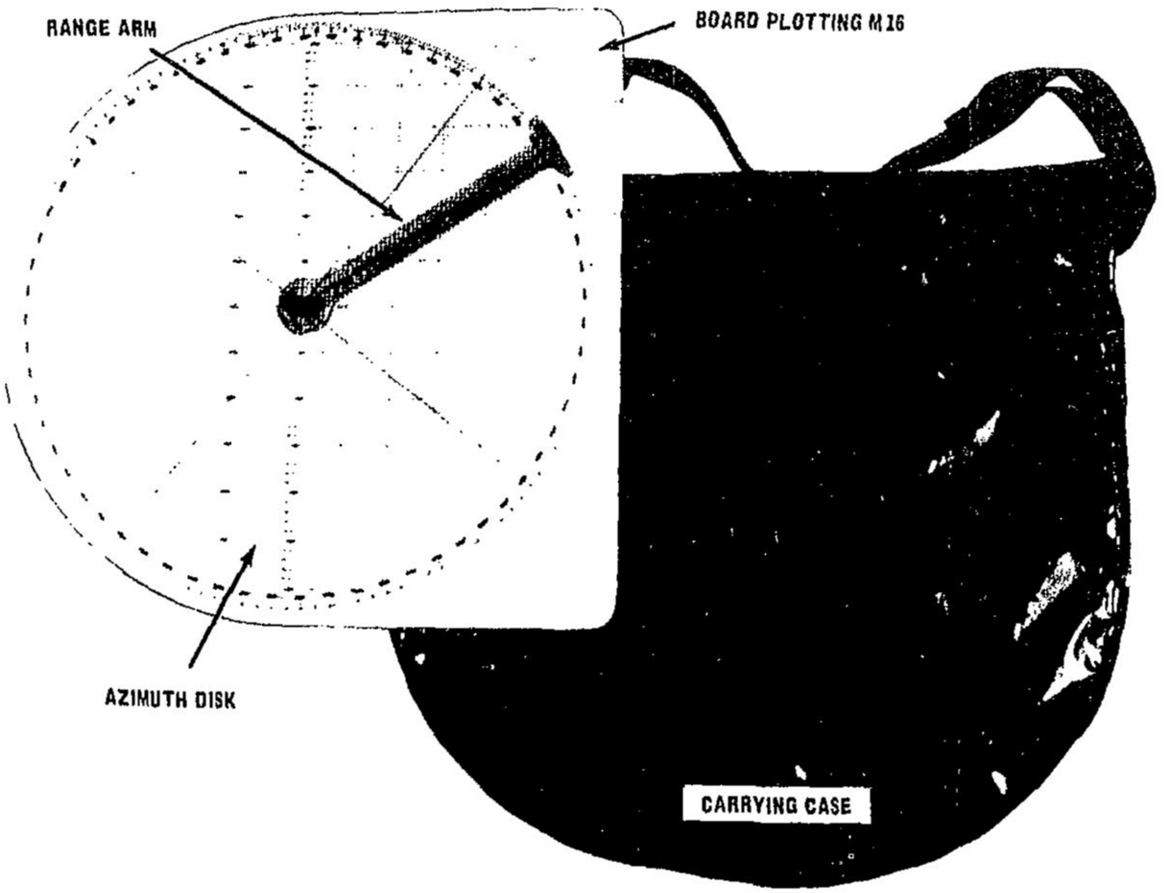


Figure 74. M16 plotting board and carrying case.

b. Transparent Plotting Disk. The rotatable disk is made of plastic. It is roughened on the upper surface to receive pencil marks. A scale on the outer edge (mil scale) runs clockwise to conform to the azimuth scale of a compass and is used for plotting azimuths and angles. The scale is divided into 10-mil increments from 0 to 6400 and is numbered in 100 mils. In addition, the disk has two black lines referred to as *centerlines.* They are printed across the center of the disk from 0 to 3200 and from 1600 to 4800 mils. They serve no purpose in mortar gunnery other than to assist in orienting the disk.

c. Range Arm. The range arm is used when the mortars are located at the pivot point. It is made of plastic and can be plugged into the pivot point. On the arm are a range scale, an index, and a vernier scale. The arm eliminates the need for rotating the disk away from the OT azimuth to read deflections.

217. Care and Preservation of the M16 Plotting Board

a. Handling. Handle the plotting board with care to prevent bending, scratching, or chipping. Avoid excessive heat or prolonged exposure to the sun, both of which may cause the board to warp. When storing the board, place it base down on a flat, horizontal surface. Do not place the plotting board on end or store other equipment on it.

b. Cleaning. Cleaning can normally be accomplished with a nongritty (art gum) eraser. If the board is excessively dirty, a damp cloth may be used. Cleaning the contact surfaces of the disk and base should be done frequently. Remove the disk by pushing a blunt instrument such as the range arm pin through the pivot point from the rear of the base. Do not attempt to remove the disk by lifting its outer edges. Do not use cleaning fluids, solvents, or gritty substances on the plastic portion

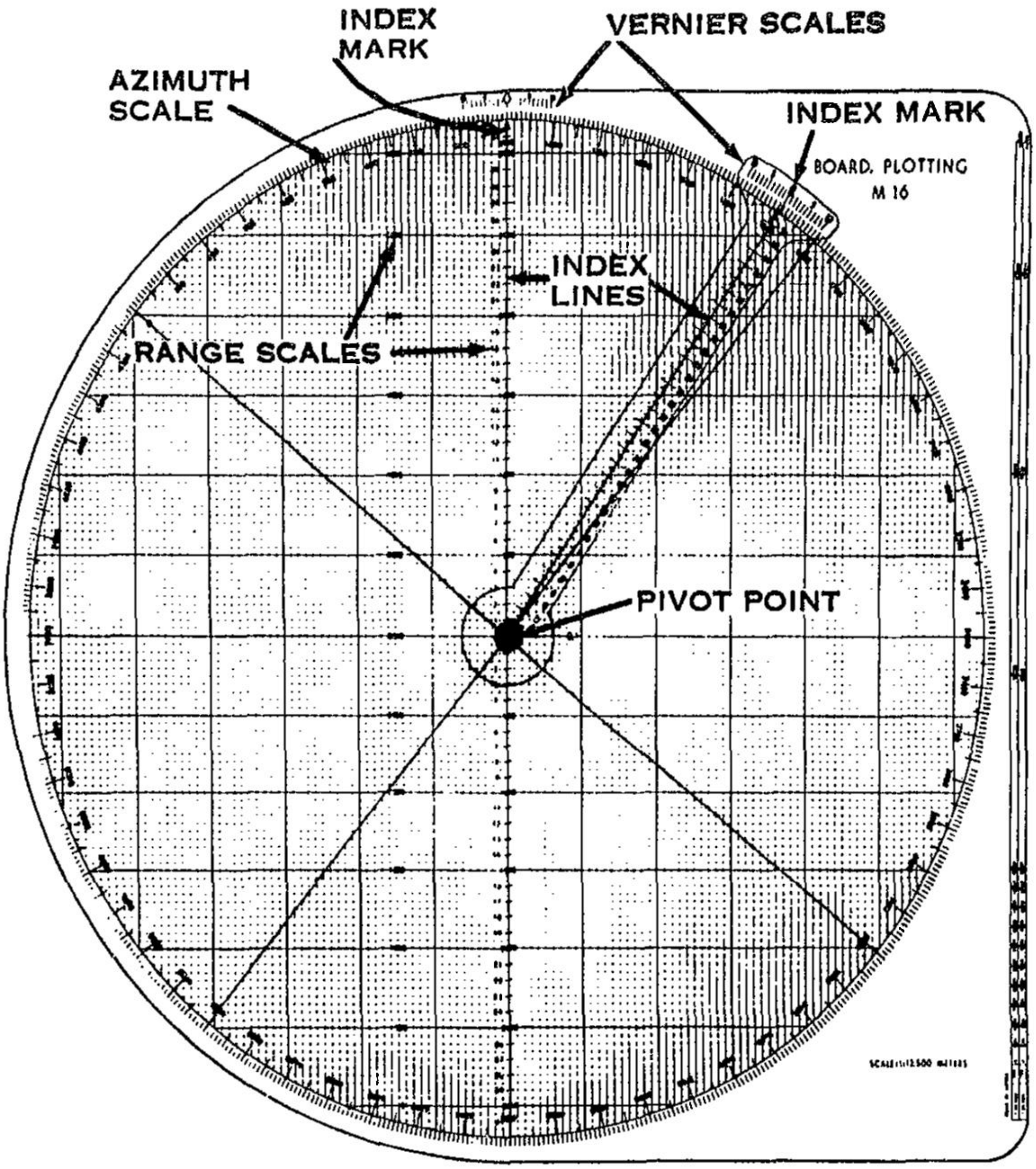


Figure 75. M16 plotting board.

of the plotting board. Cleaning solvents or paint thinner may be used on the metal surfaces.

218. Determining Firing Data from the M16 Plotting Board

Firing data can be determined with the M16 plotting board as outlined in paragraph 227. The addition of the range arm, however, eliminates the necessity of rotating the plot to the index line.

a. Determining Range With the Range Arm. Rotate the range arm until the index line of the range arm is directly over the number two plot. The range is then determined to the nearest 25 meters (fig. 76).

b. Determining Deflection With the Range Arm. Deflection is determined using the index and vernier scale on the range arm. The index of the range arm falls between deflection 2670 and 2680.

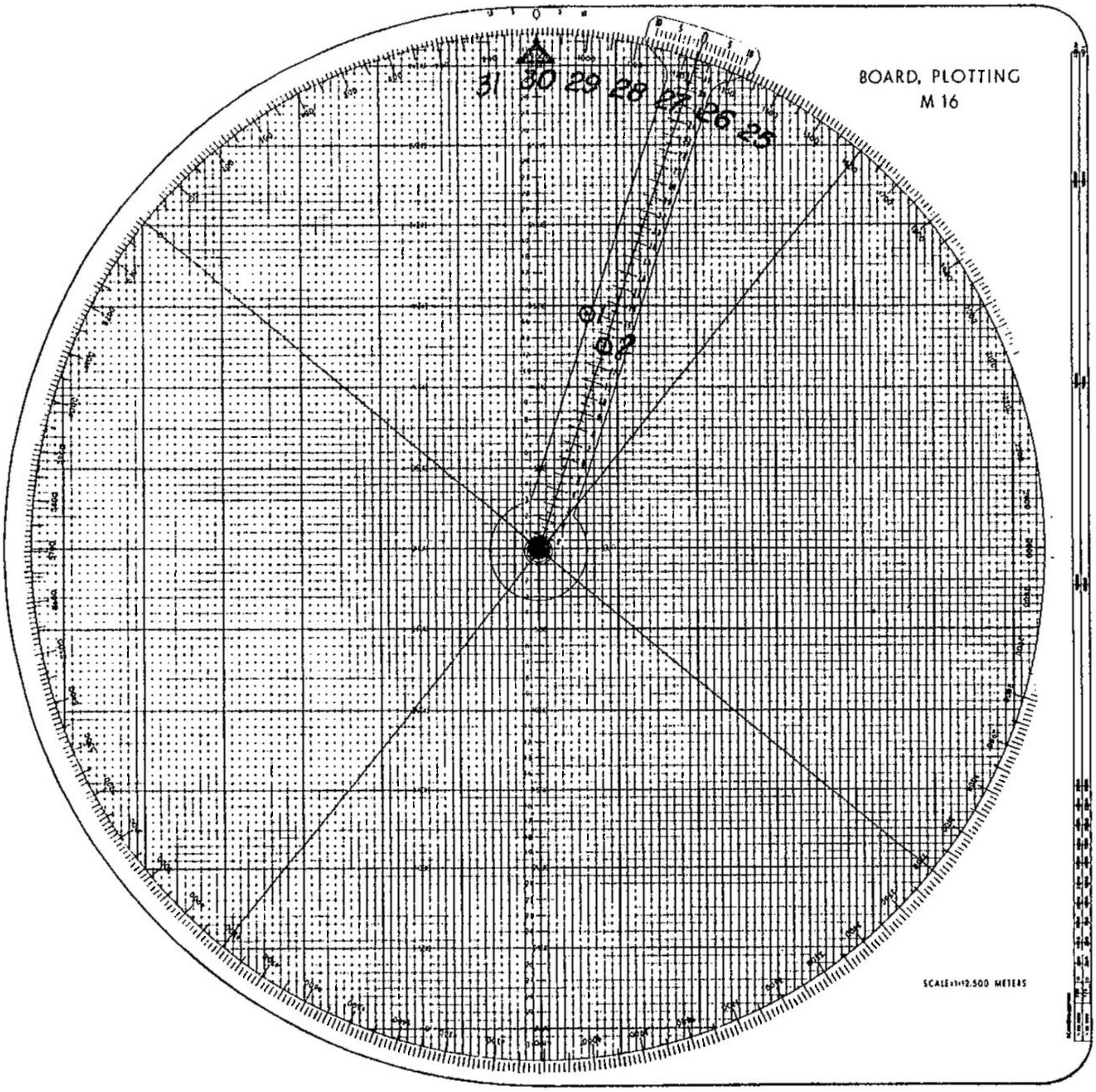


Figure 76. Use of the range arm.

The vernier scale is used to read the deflection to the nearest 1 mil. The seventh graduation of the vernier scale alines directly with one of the graduations on the deflection scale. The deflection for plot number two is meters (fig. 77).

Note. The difference between the deflection determined with the M10 plotting board and the M16 plotting board is in the reading of the vernier scale. The M10 plotting board was read to the nearest 5 mils by interpolation, whereas the M16 is read to the nearest 1 mil by the use of the vernier scale.

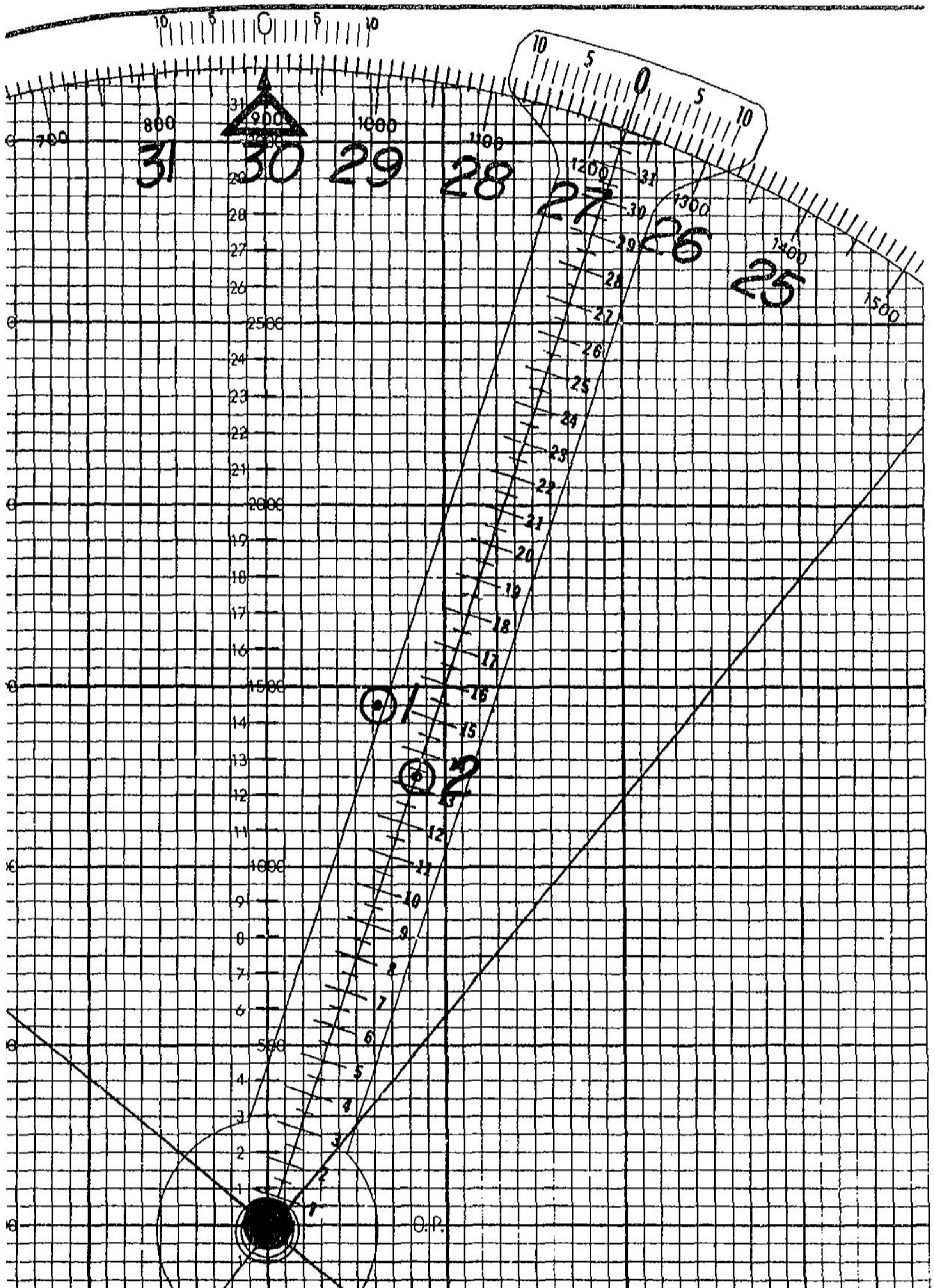


Figure 77. Use of the vernier scale.

219. General

The theory of operation of the plotting board is basically simple, and the accuracy of the results obtained is limited by the exactness of the operator. The plotting board is used to plot accurately the relative positions of the mortars, registration points, and targets, and to determine the direction and distance between these points. Since the size of the dots placed on the board affects the accuracy of the data determined, dots must be made as small as possible. To make it easier to locate these small dots, they may be encircled. In computing the data, be careful to use the dot and not the circle.

a. Any arbitrary point on the disk may be selected as the mortar position or the observation post. Whenever possible, the center (pivot point) of the board is used to represent the mortar position.

b. To plot a point with a given azimuth and distance from another point, proceed as follows:

(1) Select an arbitrary point on the disk as location of the first point and place a pencil dot. (If the pivot point is selected as the arbitrary point, it is not possible to make a pencil dot.)

(2) Rotate the disk until the stated azimuth is indicated over the index.

(3) To determine the distance on the plotting board from the first point to the second point, divide the stated distance by 50 or 100, depending on which scale on the base is used. The result is the number of squares on the base between the two points. Count off the number of squares or fractions of squares thus determined from the first point *toward the top of the plotting board*, and plot the second point. (The second point may be plotted also by measuring off the stated distance from the first point *toward the top of the plotting board* using the range scales on the base.)

c. When two or more points have been placed on the plotting board in this manner, it is possible to determine the distance between any two given points and the azimuth from one point to the other.

d. To determine the azimuth between two plotted points, the operator must remember that all parallel lines have the same azimuth. Therefore, when a particular azimuth is rotated over the index, every vertical line on the grid is pointing along that same azimuth. This means also that the azimuth of any of the vertical lines of the grid is read at the index mark. To find the azimuth of a given point with respect to another, rotate the disk until the two pencil dots lie along one of the vertical lines on the grid base or until they are the same distance from the same vertical line with the given dot (target) toward the top of the plotting board. The azimuth may then be read on the mil scale at the index on the base.

e. Determine the range between the dots in meters by counting the number of small grid graduations separating them when in this position and multiplying this number by 50 or 100, depending on which scale on the base is used. The range can also be determined by measuring the distance, using one of the range scales on the base.

220. Sample Problems

a. Determining the azimuth and range from a new mortar firing position to the target.

(1) *Given:* Mortar position at the center (pivot point) of the disk.

Mortar position to new mortar position:	Azimuth 4150 mils; distance 550 meters.
Mortar position to target:	Azimuth 5750 mils; distance 1,500 meters.

(2) *Procedure.* To determine the azimuth and range from the new mortar position to the target, using the range scale along the index line (where the smallest grid graduation represents 50 meters), proceed as follows:

(*a*) Rotate the disk until 4150 mils is read over the index on the base. Mark the disk with a pencil dot over the index line at the 550-meter graduation. This dot represents the location of the new mortar position.

(*b*) Rotate the disk until 5750 mils is read over the index on the base. Mark the disk with a pencil dot over the index

line at the 1,500-meter graduation. This dot represents the location of the target.

(c) Rotate the disk until an imaginary line connecting the two pencil dots becomes parallel with the index line. Rotate it in such a direction *that the dot representing the location of the target (TGT) is* toward the top of the board.

(d) The azimuth MORT–TGT is then read at the index mark on the base as 6110 mils. The total number of meters between the pencil dots when in this parallel position (1,400 meters above the horizontal grid line passing through the pivot plus 200 meters below) is the range MORT–TGT, 1,600 meters.

b. Problem involving the solving of survey notes.

(1) *Given.* A mortar section is placed in position by squad, each squad in a different location. The first squad is plotted at the pivot point of the plotting board. The second squad is located (surveyed) with reference to the first squad by compass and pacing. A traverse of two legs is made to the second squad from the first squad as follows:

First leg—azimuth 4800, distance 200 meters.

Second leg—azimuth 5400, distance 250 meters.

(2) *Procedure.* To plot the location of the second squad with reference to the first squad, proceed as follows:

(a) Use the range scale along the index line.

(b) Rotate the disk until azimuth 4800 is at the index. Count up 200 meters along the red index line and make a pencil dot.

(c) Rotate the disk until azimuth 5400 is at the index. From the pencil dot just plotted, count up 250 meters and make a pencil dot. This is the location of the second squad. (The same procedure would be used to locate the third squad.)

Note. To determine the azimuth and direction from the first squad to the second squad, rotate the disk until the plotted location of the second squad is toward the top of the plotting board and is on the same vertical line or the same distance from the same vertical line as the first squad plot (in this case on the red index line). The azimuth is 5120 mils and the distance is 425 meters.

221. Other Uses for Plotting Board

In addition to the examples illustrated above, the plotting board can be used to compute angles of site, to make simple sketches which require azimuths and pacing, to follow azimuths for various paced distances, to indicate the friendly frontline, and as a firing chart to compute firing data for one or more indirect fire weapons.

222. Observed Firing Chart (Plotting Board)

a. The plotting board is used at the FDC as an observed firing chart on which the locations of the registration points are plotted in relation to the firing position from date obtained by registration firing (fire adjustment).

b. The pivot point of the plotting board is arbitrarily selected as the location of the base mortar (usually the No. 2 mortar) in the firing position. The registration data (MORT–TGT range and corrected magnetic azimuth) determined by adjusting on the registration point are then used to plot the location of the registration point with respect to the firing position. New targets reported by FO's are plotted on the firing chart with respect to the registration points or other reference points (such as numbered targets previously adjusted upon, marking rounds, or FO locations) whose chart locations are known at the FDC. An observed firing chart permits accurate firing at night or under conditions of poor visibility on any target whose chart location is known at the FDC.

c. The observed firing chart is used to—

(1) Plot the location of the registration point with respect to the firing position (base mortar).

(2) Plot the location of forward observers when their location is known or desired.

(3) Plot new targets reported by FO's with respect to reference points (such as reference points, numbered targets, or marking rounds) whose chart locations are known at the FDC.

(4) Plot new targets by polar coordinates when the observer's location is known at the FDC.

(5) Plot new targets by grid coordinates when the observer has a map.

(6) Determine the MORT–TGT range and

direction (deflection) for each cartridge fired during an adjustment.

(7) Determine special corrections for each mortar to fit a target of special shape.

(8) Mass fires of the unit on any target whose chart location is known at the FDC.

(9) Plot the location of friendly forward elements (frontline troops).

d. Frequently the FO does not have a map to determine coordinates. His target designation is usually made with reference to a point whose chart location is known at the FDC. When a new target is reported with reference to a target previously fired upon and plotted on the firing chart, the firing data (range and direction) is determined with the plotting board for each cartridge fired during the adjustment and fire for effect. When the fire mission is completed, the target is replotted using the adjusted fire data (data for replot). However, if too many targets are plotted on the plotting board, the chart (plotting board) becomes so cluttered with detail that it hampers the conduct of subsequent fire adjustments. Therefore, it is desirable to plot on the plotting board only those targets which are likely to be used by FO's as reference points for reporting the location of new targets.

e. If a new target is reported with reference to a previous target whose chart location is known at the FDC and whose plot has been removed from the plotting board, the latter target (reference point) is replotted on the plotting board for this particular fire mission. The data for replotting this target (reference point) on the plotting board is obtained from the firing data sheet.

f. Maps and photomaps may be used to plot targets on the firing chart which are located and reported by map or photomap coordinates.

g. Firing data (range and deflection) is determined on the plotting board with respect to the previously plotted point. A protractor and ruler or coordinate scale are used in determining initial firing data from a map.

223. Preparation of Plotting Board for Initial Registration

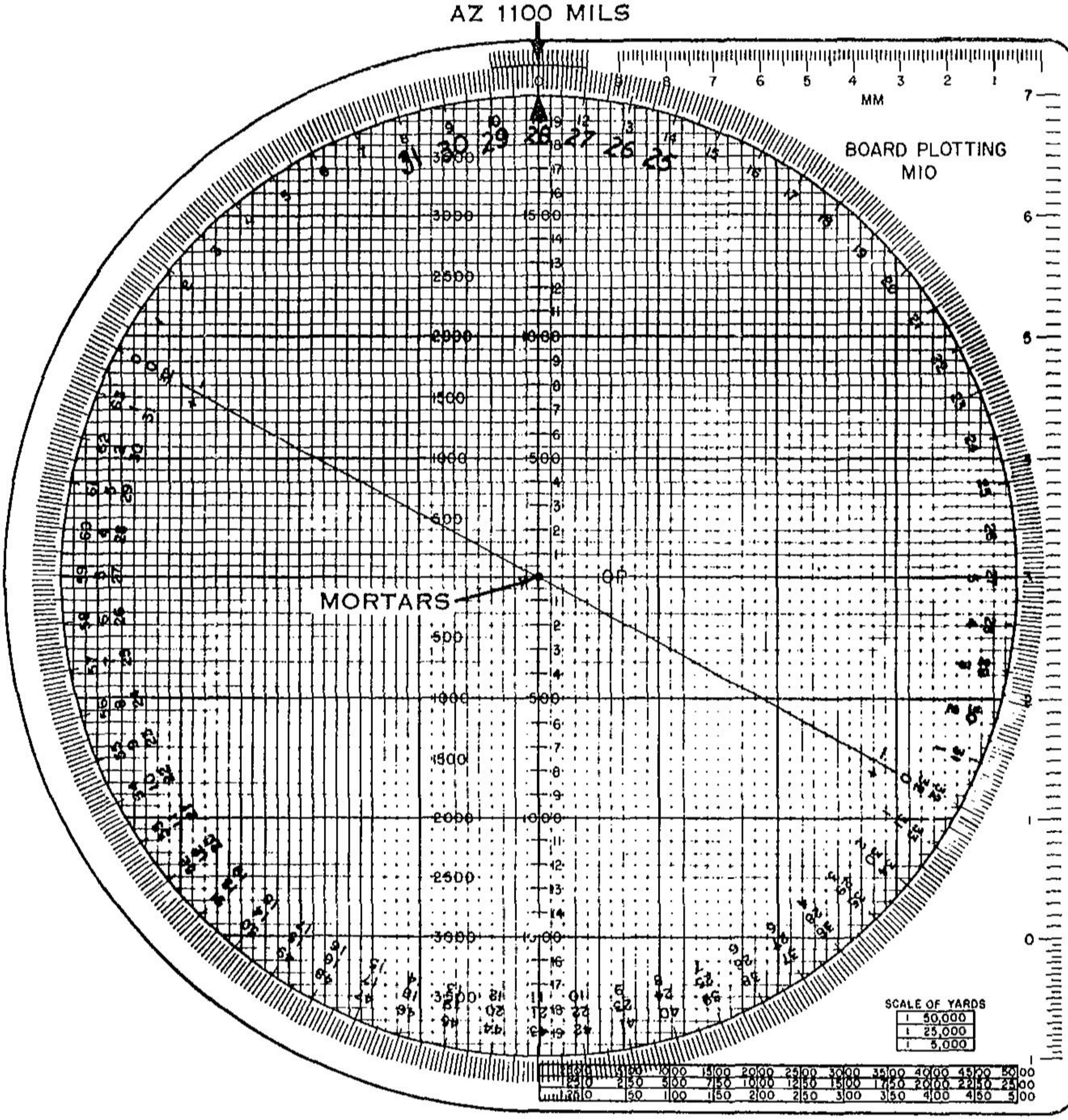
a. Whenever possible, select the pivot point of the plotting board as the location of the firing position. Actually, the pivot point represents the base mortar.

b. Rotate the disk until the azimuth read over the index on the base is the same as the azimuth on which the mortars are laid (initial azimuth to the registration point or azimuth of center of sector *determined to the nearest 50 mils*).

c. Since it is impossible for the gunner to place an azimuth reading on the sight, the computer must convert azimuths to deflections. He does this by superimposing a deflection scale over the appropriate position on the azimuth scale. The referred deflection used to place out the aiming stakes is the deflection marked underneath the mounted azimuth. For example, if aiming posts are placed out on a referred deflection of 2800 mils, the computer enters 28, representing 2800 mils, underneath the center of sector azimuth. Since deflection increases in a counterclockwise direction (to the left), the remainder of the deflection scale is marked below the azimuth scale with increasing 100-mil deflections to the left of 2800 mils and decreasing 100-mil deflections to the right of 2800 mils, spaced every 100 mils (fig. 78). As many 100-mil deflections may be marked as needed, depending on the sector of fire of the mortar unit.

d. As soon as the observer's call for fire is received, the computer marks with an OP symbol (Δ) the graduation on the mil scale of the plotting board which corresponds to the OT azimuth reported by the observer in his call for fire. For example, the FDC receives the following call for fire from an observer: OP NUMBER ONE, FIRE MISSION, MARK CENTER OF SECTOR, DIRECTION NINE HUNDRED, REGISTRATION, ADJUST FIRE. He marks the 900-mil graduation on the mil scale with an OP symbol to indicate that it is the OT azimuth (fig. 79).

e. The direction in which the cartridge is to be fired is the azimuth to the center of the sector (determined by map to be 1120 mils, rounded off to 1100 mils). The range is selected to insure that the round will clear the friendly forward battle area and burst in an area where the observer can see it. When the location of friendly forward troops has been obtained, the computer draws a line on the plotting board to represent the location. The computer plots the cartridge on the plotting board with the direction and range as determined above (fig. 80). He determines and issues the fire command to the firing position.



AZIMUTH TO CENTER OF SECTOR 1120 MILS. MORTARS MOUNTED ON AZIMUTH 1100 AND AIMING STAKES PLACED OUT ON A REFERRED DEFLECTION OF 2800 MILS

Figure 78. Plotting board prepared for initial registration.

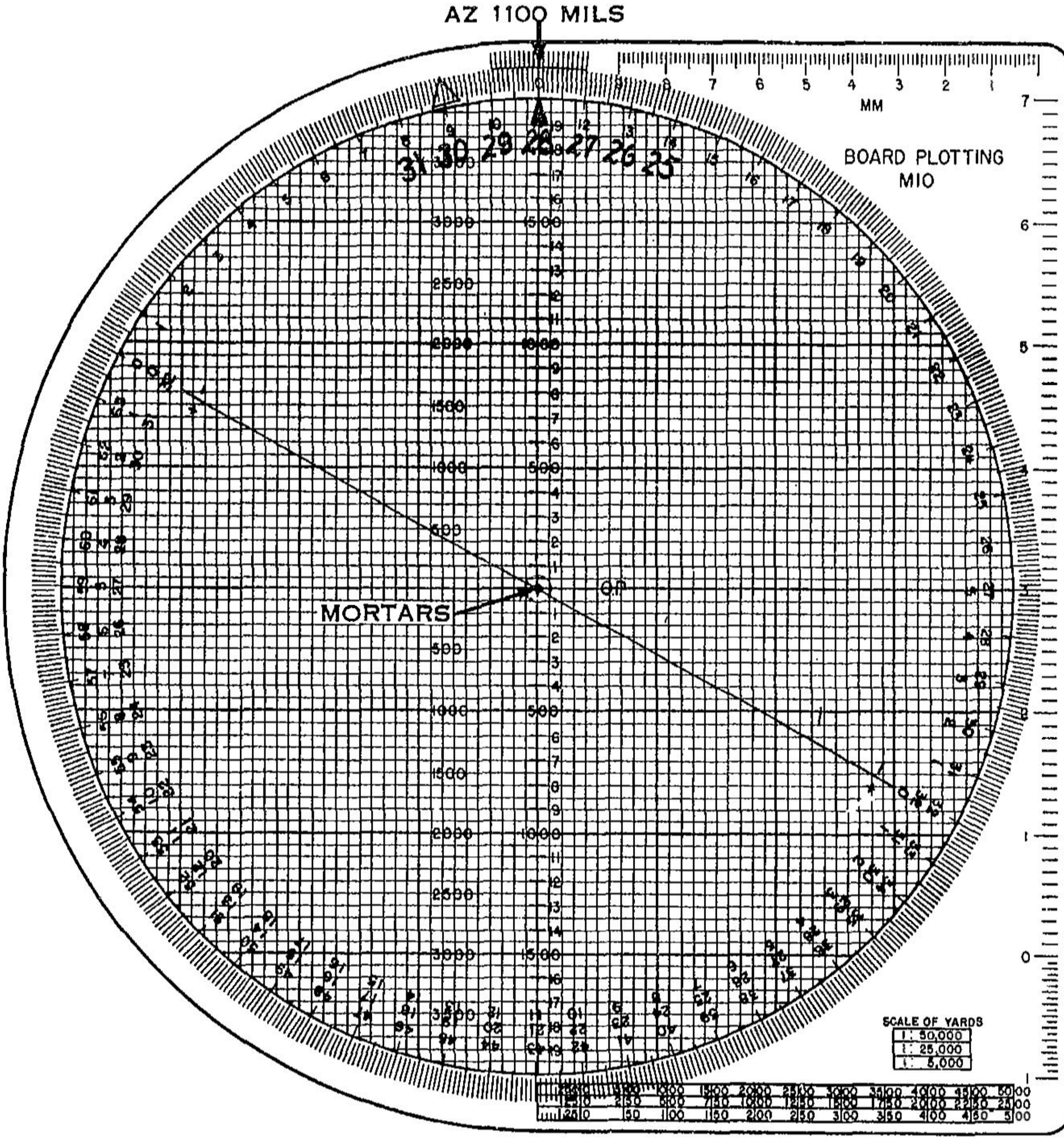


Figure 79. Marking OT azimuth on plotting board.

224. Orientation of Plotting Board on OT Azimuth

Before information reported to the FDC by the FO is plotted, the plotting board is oriented by rotating the disk until the azimuth read over the index on the base is the same as the OT azimuth reported by the observer in his call for fire.

225. Plotting Observer's Subsequent Corrections on Plotting Board

After orienting the plotting board on the OT azimuth, the computer plots subsequent corrections reported by the FO by moving right or left so much from the previous plot along a grid line perpendicular to the index line on the base (target grid) and adding or dropping so much along the index line or one of the grid lines parallel to it. Figure 81 shows the computer's plot of the observer's subsequent correction, RIGHT ONE HUNDRED, DROP TWO HUNDRED. In this manner, the initial target (or registration point) location is plotted with respect to the OT line by shifting from the initial plot (initial round marking center of sector). Subsequent corrections throughout an adjustment are plotted in a similar manner for each round, volley, or salvo to be fired, moving from the location of the previously plotted point (target location).

226. Use of Plotting Board with M4 Sight

a. The plotting board is operated in the same manner with the M4 sight as with the M34A2 sight unit. In preparing the plotting board for firing, the M4 sight deflection scale replaces the aiming stake system used with the M34A2 sight unit.

b. The computer prepares the plotting board in the following manner: The plotting board disk is rotated until the azimuth read over the index on the base is the same as the azimuth on which the mortars are laid. The deflection at which the aiming stakes are placed out is marked on the plotting board opposite the azimuth on which the mortars are laid. The deflection scale is continued on the plotting board every 150 mils, corresponding to the deflection scale of the M4 sight (fig. 82).

c. To determine the deflection, shift from the nearest aiming stake. If the index is less than halfway (75 mils) to the additional stake from the base stake, determine the deflection from the base stake.

Example: LEFT 40 FROM BASE STAKE. If the index is over halfway (75 mils) to the next additional stake, determine the deflection to that stake.

Example: RIGHT 50 FIRST LEFT STAKE. Deflections are determined to the nearest 5 mils.

227. Determining Firing Data from Plotting Board

After plotting the forward observer's corrections, the computer rotates the disk of the plotting board until the pencil dot representing the last correction from the observer is directly over the index line on the base. The direction (deflection) to be announced to the adjusting mortar is then read at the index on the base. The range at which the round is fired is determined by referring to the range scale along the index line (fig. 83).

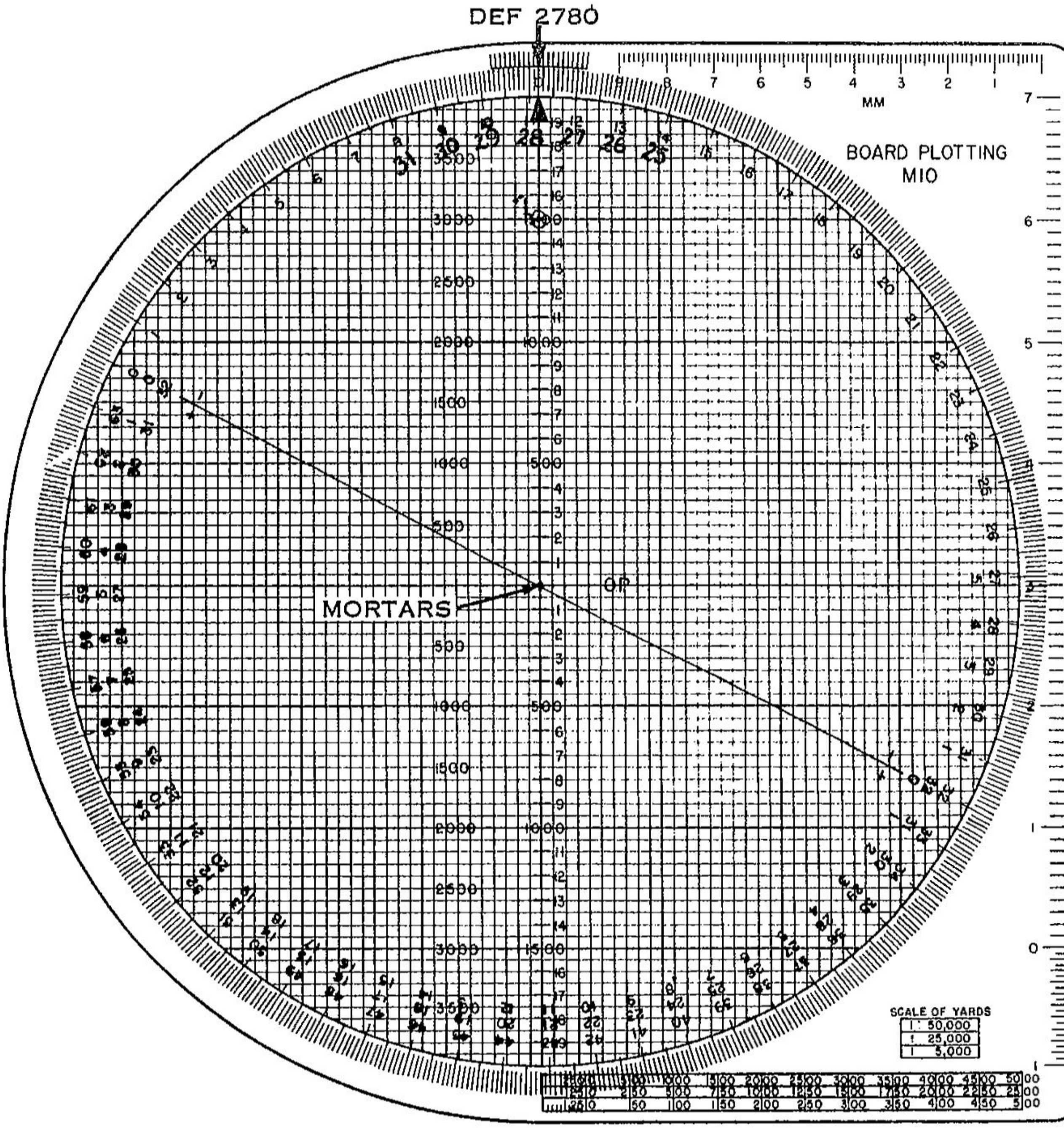
228. Preparation of Observed Firing Chart

The final target (registration point) plot made on the plotting board during the registration becomes the permanent plot and is labeled.
The OP symbol and all other plots made during the registration are removed. Data determined from this final registration point plot (adjusted MORT-TGT range and corrected grid azimuth) are recorded on the firing data sheet. The computer then directs the observer to adjust a parallel sheaf of the unit on the registration point.

229. Plotting New Targets on Observed Firing Chart

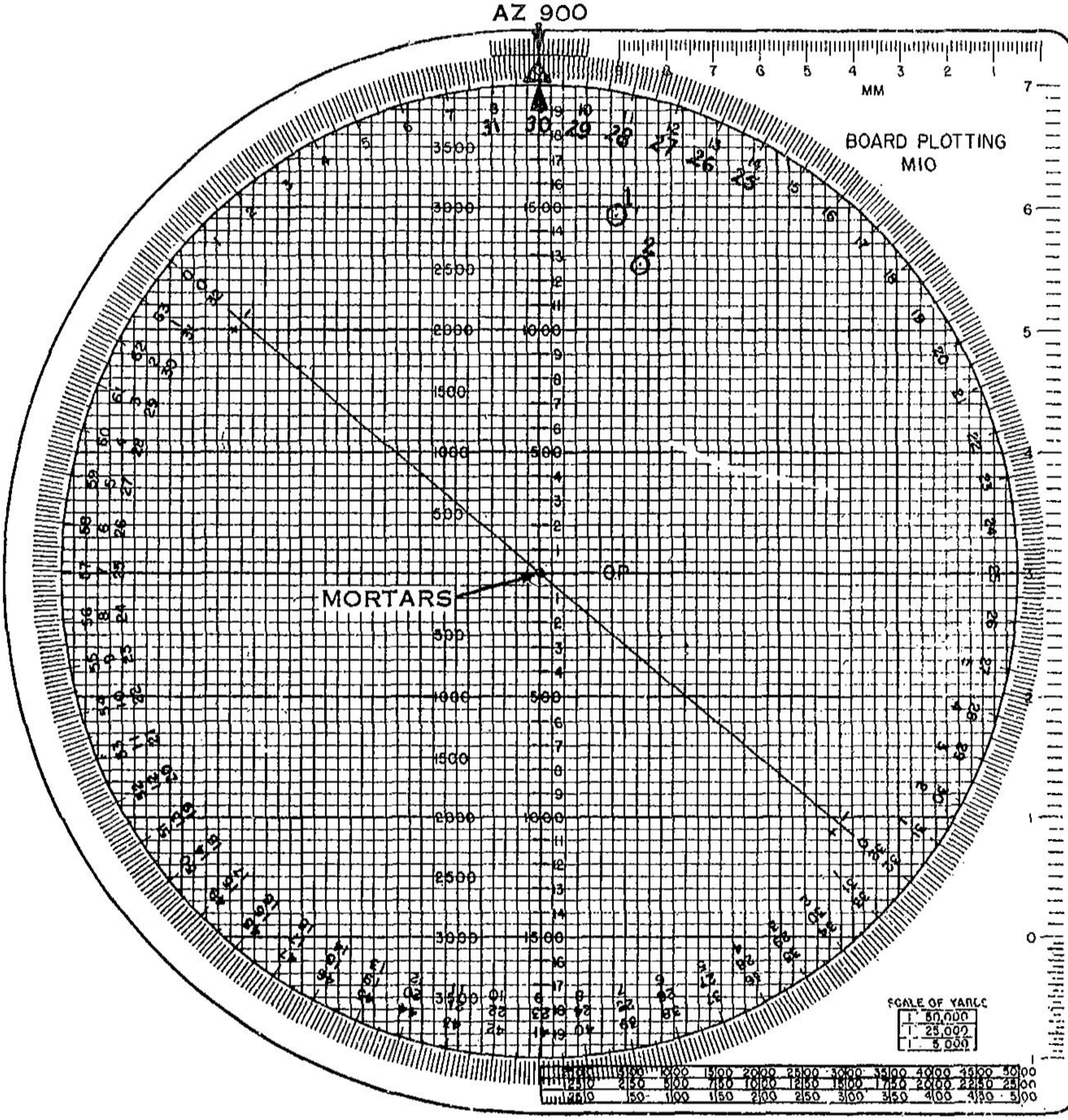
a. After orienting the plotting board on the OT azimuth, the computer plots the initial target location given in the observer's call for fire, moving right or left so much *from the reference point* (*registration point or numbered target*) along a grid line perpendicular to the index line on the base, and adding or dropping so much along the index line or one of the grid lines parallel to it (fig. 84).

b. Subsequent corrections throughout an adjustment are plotted in a similar manner (board oriented on OT azimuth) for each round, volley, or salvo to be fired, moving from the location of the previously plotted point (target location). The computer determines the firing data by rotating the disk until the plotted correction is



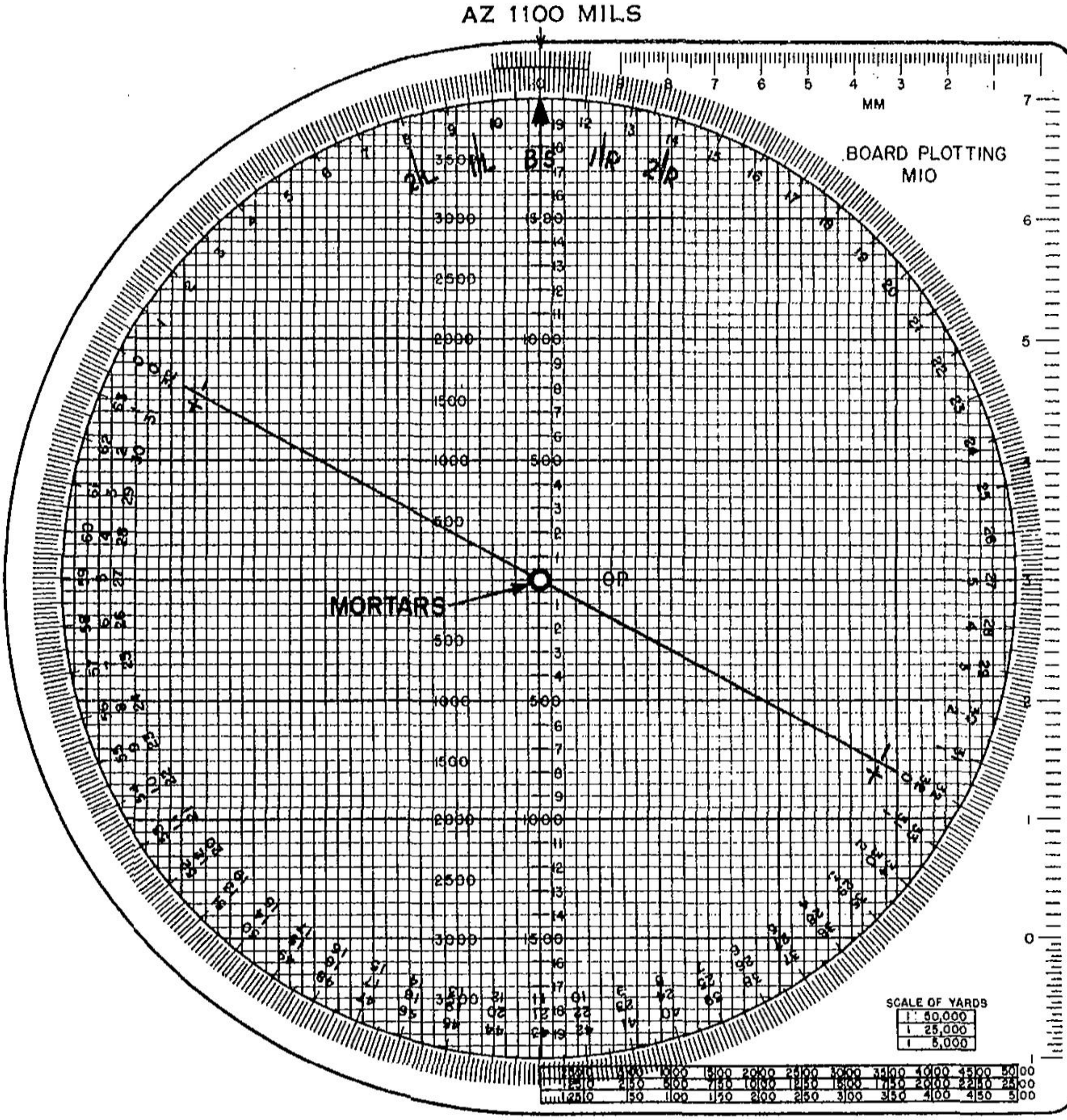
FIRING DATA FOR MARK CENTER OF SECTOR ROUND.
DIRECTION–DEFLECTION 2780
RANGE–1500 YARDS

Figure 80. Determining firing data for a mark center of sector round.



SUBSEQUENT CORRECTION FROM OBSERVER: "RIGHT ONE HUNDRED. DROP TWO HUNDRED." COMPUTER MOVES FROM INITIAL PLOTTED POINT (#1) RIGHT 2 SMALL GRID GRADUATIONS (100 YARDS): DOWN 4 SMALL GRID GRADUATIONS (200 YARDS), AND MARKS INITIAL REGISTRATION POINT LOCATION WITH A PENCIL DOT (#2).

Figure 81. Plotting observer's corrections.



AZIMUTH TO CENTER OF SECTOR 1120 MILS. MORTARS MOUNTED ON AZIMUTH 1100 AND BASE STAKE MARKED ON THIS AZIMUTH. FOUR ADDITIONAL AIMING STAKES ARE PLACED OUT.

Figure 82. Preparation of plotting board for initial registration (M4 sight).

over the index line. After fire for effect, when the observer informs the FDC that the mission is accomplished, the computer removes the OP symbol and the plots for all the observer's corrections except the final one. This, he labels as target number AB 750 (or AB 751, etc.).

230. Plotting New Target on Observed Firing Chart by Map Coordinates

a. When the FDC is controlling the fires of the mortar unit with the plotting board, targets located by map coordinates can be transferred to the plotting board when the registration point or numbered target (which has been identified on the map) is plotted on the board. With the map, the computer determines the azimuth and distance from the registration point or numbered targets to the target. The computer rotates the disk until this grid azimuth appears over the index and, marking off the proper distance, plots the location of the target. The computer can now determine the firing data to this target from the mortar position. Before fire for effect is delivered on the target, the latest correction factors are applied to the firing data.

b. In fast moving situations, the above methods of locating targets by map coordinates may be too slow and inaccurate for delivering fire on selected targets. This would be especially true for moving targets or troops digging in, when fire for effect must be placed on the target as quickly as possible. An alternate method is as follows (fig. 85).

(1) Orient the plotting board so that the azimuth 0 (Grid North) is at the index.

Note. In this example, the map scale is 1/25,000 meters. Each small square measures 100 meters and each large square 1,000 meters (the size of each grid square on the map).

(2) Number the grid coordinates on the plotting board. (When placing the grid system on the board, make sure that the mortar position will fall below the pivot point when oriented on the mounted azimuth. This insures that all expected targets can be plotted on the board for range and that the entire company sector will be covered.)

(3) Plot the location of the mortar position (by grid coordinates). Coordinates of mortar position 21505135.

(4) Place in the deflection scale. (Mortars are mounted on grid azimuth 1200 m.

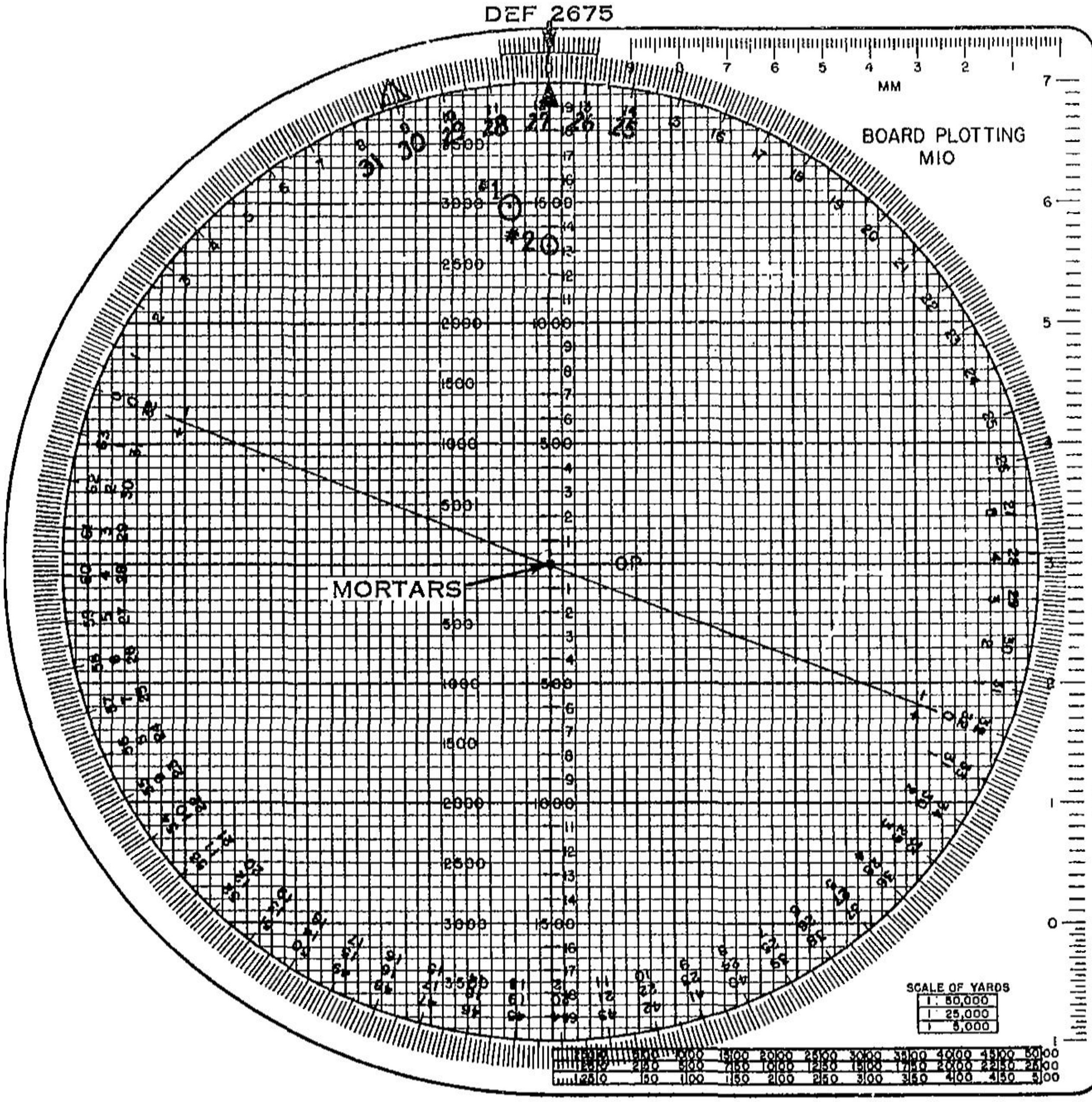
(5) When targets are called in by grid coordinates, the computer can plot the target location on the plotting board, just as he would on a map. After the target has been plotted, the computer determines the firing data by rotating the disk so that the mortar position and the target plot are along the same vertical line (parallel line principle), with the mortar position toward the bottom of the board. The computer reads the deflection to the target at the index mark and determines the range using the range scale. He completes the fire command and fire is then placed on the target.

Note. Correction factors are applied when necessary (para 249).

231. Plotting Location of Observer on Firing Chart

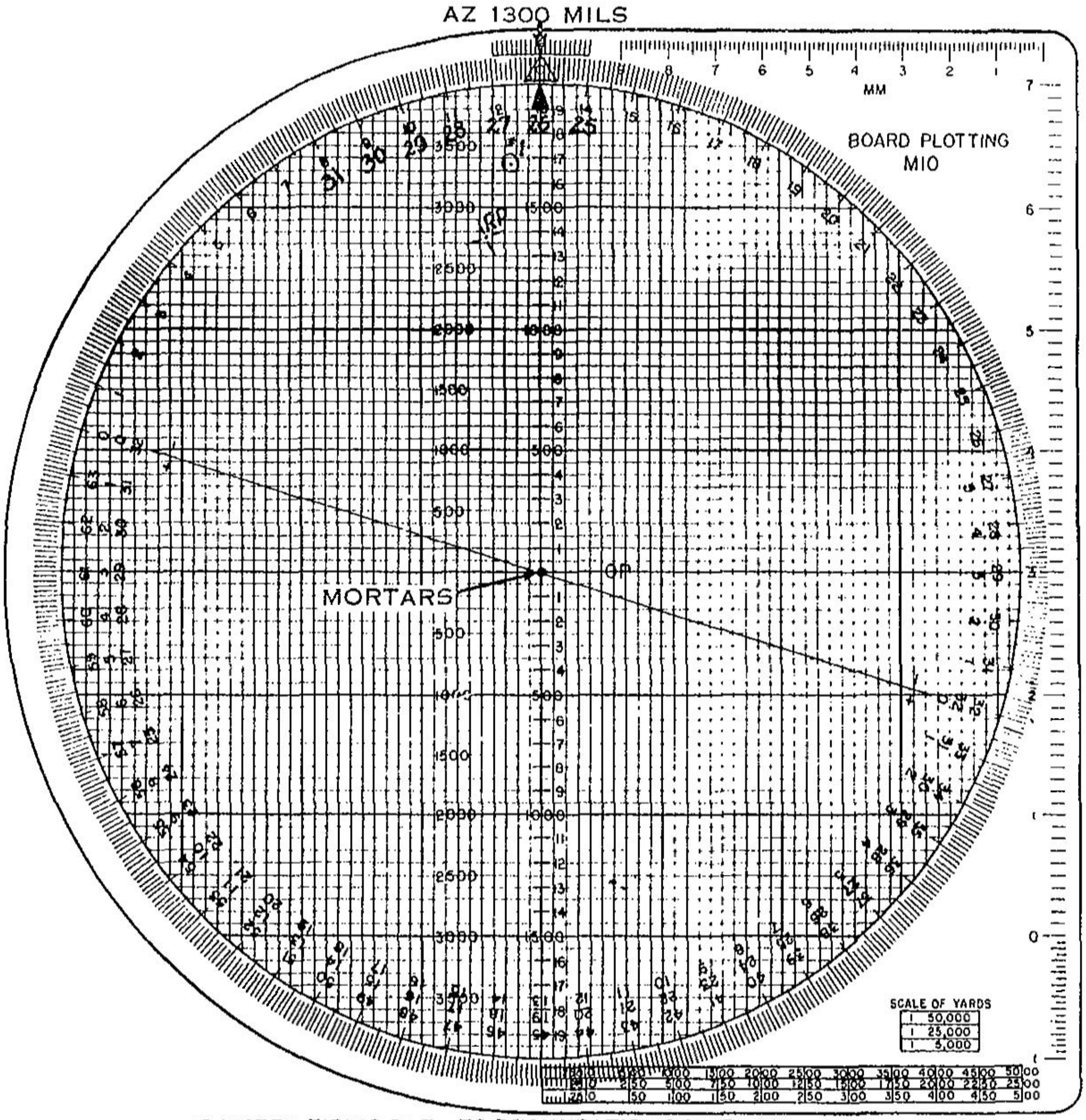
a. By Resection. The computer directs the observer to give the azimuth from his OP to two reference points whose locations are plotted on the plotting board. The computer then orients the board on the azimuth to one reference point. He draws a line from this reference point along a vertical grid line or parallel to the nearest vertical grid line toward the bottom of the board. He does the same for the other reference point. The point of intersection of the two lines is the location of the observer. For greater accuracy, the angle of intersection should be between 500 and 2700 mils.

b. By Pacing From Mortar Position. If the OP is close enough to the mortar position, the loca-



FIRING DATA DETERMINED FROM LAST CORRECTION BY OBSERVER (#2):
DEFLECTION—2675
RANGE—1325 YARDS

Figure 83. Determining firing data from plotting board.



ADJUSTED FIRING DATA TO REGISTRATION POINT
DIRECTION–DEFLECTION 2760
RANGE–1400 YARDS

INITIAL TARGET CALL FROM AN OBSERVER TO ENGAGE A NEW TARGET.

"OP ONE, FIRE MISSION FROM REGISTRATION POINT. DIRECTION ONE THREE HUNDRED. RIGHT ONE HUNDRED, ADD THREE HUNDRED. STRONG POINT. ADJUST FIRE."

COMPUTER COUNTS FROM REGISTRATION POINT RIGHT 2 SMALL GRID GRADUATIONS (100 YARDS), UP 6 SMALL GRID GRADUATIONS (300 YARDS), AND MARKS THE INITIAL TARGET LOCATION WITH A PENCIL DOT (#1).

Figure 84. Plotting a new target.

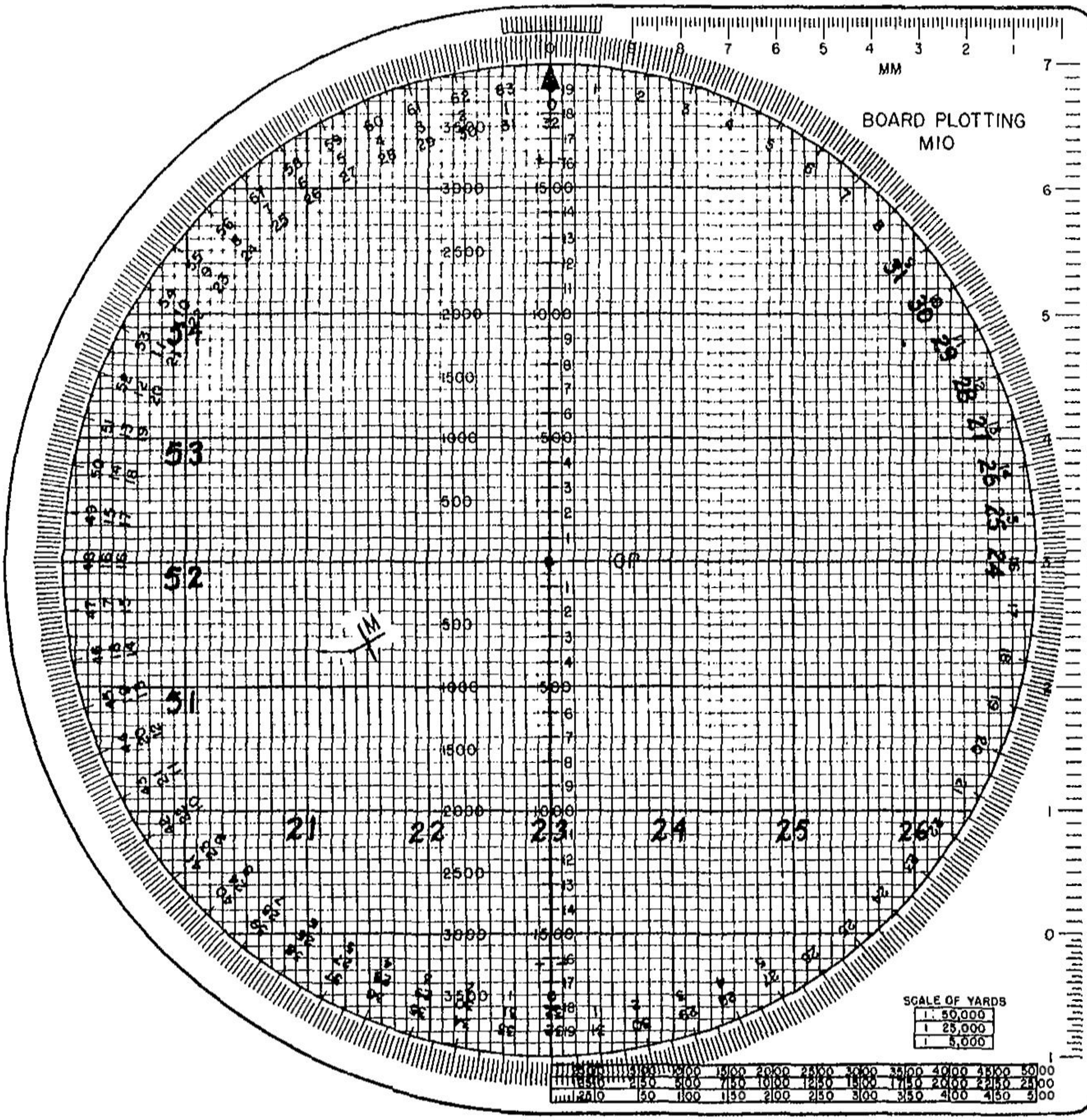


Figure 85. Locating targets by map (grid) coordinates (placing grid system on plotting board).

tion of the OP for the purpose of plotting may be determined by making a rough survey as follows:

(1) Take a grid azimuth reading from the No. 2 mortar position to the OP.

(2) Pace (or tape) off the distance from the No. 2 mortar to the OP.

(3) Orient the plotting board on the mortar-OP azimuth determined in (1) above, count up the index line the number of meters determined in (2) above, and plot the location of the OP at this point.

232. Plotting New Target on Observed Firing Chart by Intersection

When the location of two observers is known and plotted on the plotting board, the computer may plot the initial location of a new target by intersection. The procedure is as follows:

a. The chief computer plots the location of two observers with respect to the mortar position, and then directs each observer to read the azimuth from his OP to the new target and to report the azimuth read.

b. The computer rotates the disk to the azimuth read by one observer. He draws a line from this observer's location along one of the vertical grid lines or parallel to the nearest vertical grid line toward the top of the plotting board.

c. He follows the same procedure for the azimuth reported by the other observer.

d. The point of intersection of the two lines is the location of the target. For greatest accuracy, the angle of intersection should be between 500 and 2700 mils.

233. Plotting New Target on Observed Firing Chart by Polar Coordinates

When the chart location of an FO is known and plotted on the firing chart, the initial location of a new target may be plotted by polar coordinates. This method is particularly desirable in the case of large lateral shifts and short observing (OT) distances. The computer plots the new target on the azimuth and at the distance from the observer's plotted location as reported by the observer in his call for fire (fig. 86).

234. Correcting Misorientation of Plotting Board (Target Grid)

The observer may send the FDC an OT azimuth which is in error. The resulting error in orientation of the plotting board (target-grid) on the OT azimuth should be corrected if it is large enough to cause the observer difficulty in adjustment.

Example: The observer's first correction results in a burst which is short and on the OT line (plot No. 1) (fig. 87). His next correction is ADD TWO HUNDRED. The computer moves 200 meters (4 small grid graduations) up to the OT line (index line or grid line parallel to it which passes through the target plot) from plot 1 and marks the corrected location with a pencil dot (plot 2). A round is fired with the data obtained from this plot (plot 2). The observer's next correction of RIGHT ONE HUNDRED indicates that the reported OT azimuth is in error. The computer moves right 100 meters (2 small grid graduations) from plot 2 and marks with a pencil dot (plot 3) the position of the constructed line shot on the firing chart (plotting board). If this round (data from plot 3) bursts on the OT line (observer's correction for the cartridge is DROP ONE HUNDRED) the computer rotates the disk until an imaginary line connecting plots 1 and 3 is parallel to the index line or any grid line parallel to the index line. The plotting board is now oriented correctly on the OT azimuth and the corrected OT azimuth is read over the index on the base. The OP mark on the mil scale is moved to the corrected OT azimuth graduation. The plot for the next round (DROP ONE HUNDRED) is made with the disk oriented on the corrected OT azimuth.

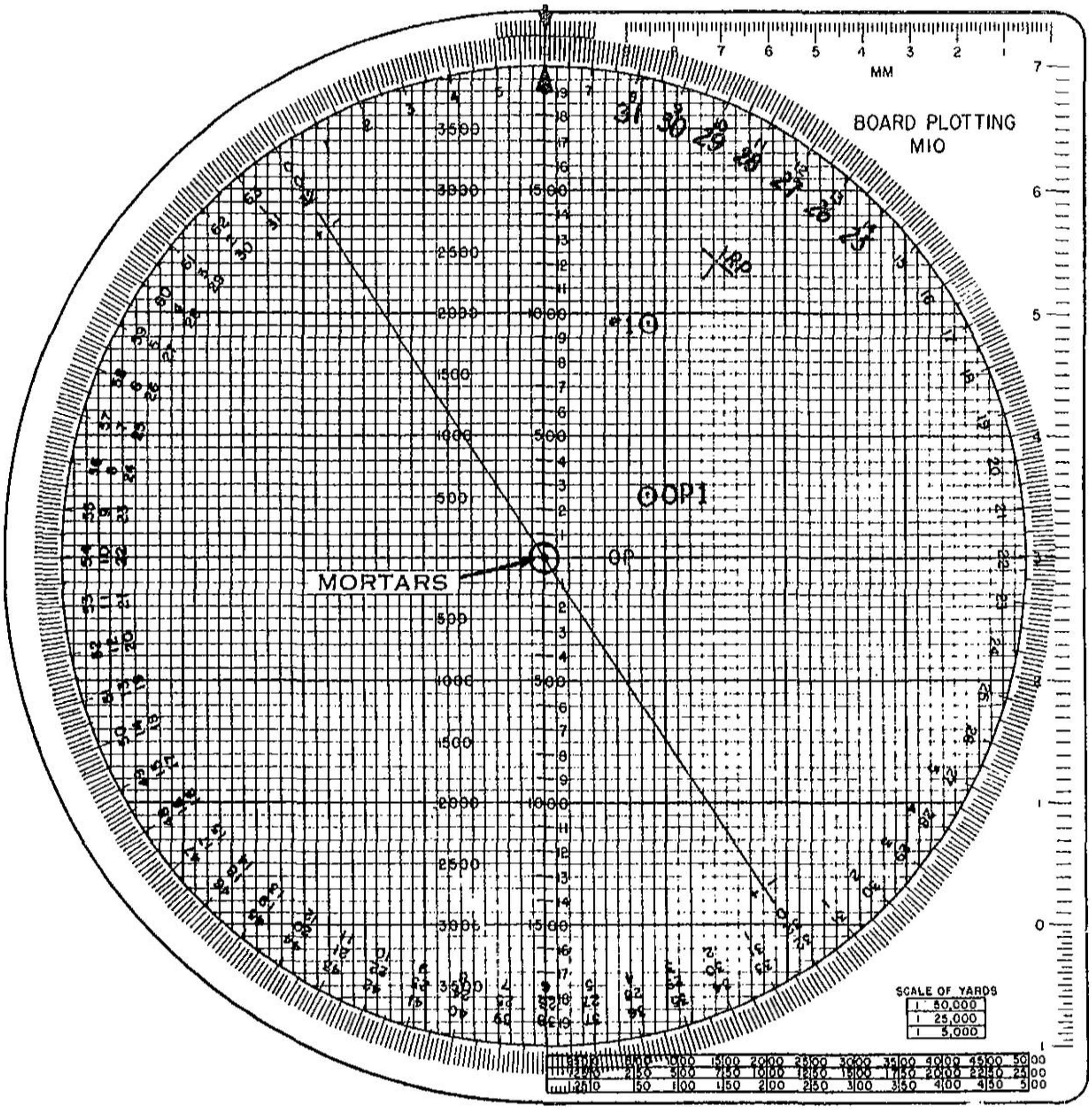
235. Determining Initial Data by Use of Plotting Board

a. This method of determining initial data (mounting azimuth and range for MCS round) will normally be used when the platoon leader or the FO can see both the target (center of sector) and the mortar position from the OP, and *maps are not available.*

Example: From his location at the OP, the platoon leader picks a terrain feature to use as a registration point in or as near as possible to the center of the sector. He reads the azimuth (compass or aiming circle) to the target as 4900 mils and estimates the observer-target range to be 1,500 meters. Looking back to the mortar position (or to a terrain feature which he knows to be located at or near the mortar position), he reads the azimuth to be 500 mils and estimates the range from the OP to the mortar position to be 400 meters.

b. The platoon leader sends this information to the chief computer and instructs him to have the mortars mounted. In determining the initial data, the chief computer locates the OP at the pivot point. He rotates the disk so that an azimuth of 4900 mils is at the index. This is the OT azimuth. He then goes up the index line to a range of 1,500 meters and places in a dot, which locates the target on the plotting board.

c. He rotates the disk so that an azimuth of 500 mils is at the index. He locates the mortar position by going up the index line a distance of 400 meters and placing a cross (mortar symbol).



OBSERVER AT OP 1 REPORTS THE AZIMUTH FROM HIS OP TO THE REGISTRATION POINT AS 900 MILS AND THE ESTIMATED DISTANCE AS 1000 YARDS. COMPUTER ORIENTS PLOTTING BOARD ON AZIMUTH 900. BACK PLOTS 1000 YARDS, PLACES A DOT AND LABELS IT "OP 1."

CALL FOR FIRE IS RECEIVED FROM OP 1: "OP ONE, FIRE MISSION, DIR SIX HUNDRED. OT DISTANCE SEVEN HUNDRED. MACHINE GUNS. ADJUST FIRE."

COMPUTER ORIENTS PLOTTING BOARD ON AZIMUTH 600, PLOTS 700 YARDS (14 SMALL GRID GRADUATIONS) FROM OP 1 TOWARD THE TOP OF THE PLOTTING BOARD ON A LINE PARALLEL TO THE NEAREST VERTICAL GRID LINES. HE THEN MARKS THE INITIAL TARGET LOCATION WITH A PENCIL DOT (#1).

Figure 86. Plotting new target on plotting board by polar coordinates.

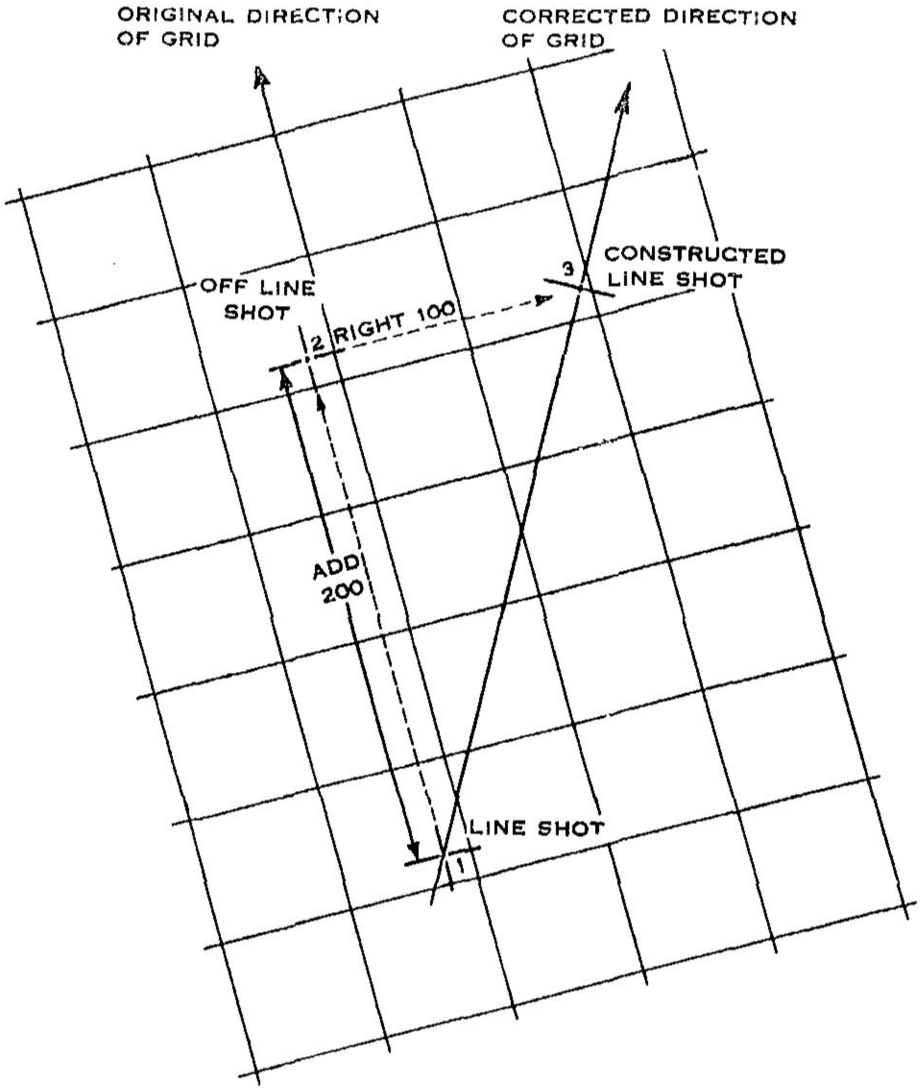


Figure 87. Correcting misorientation of plotting board.

d. The chief computer rotates the disk until a line between the dot representing the target and the cross representing the mortar position is parallel to the index line. He reads the azimuth at the index to be 4670 mils. The chief computer would order the mortars to be mounted on an azimuth of 4650 mils, since mortars are mounted to the nearest 50-mil azimuth for easier reading of the deflection scale.

Note. In performing this operation, the cross representing the mortar must be kept at the bottom of the board. The computer desires to read the azimuth *from* the mortar *to* the target at the index.

e. To obtain the range from the mortar position to the target, the computer counts the grid squares between the cross and the dot (each square 50 meters), and determines a range of 1,700 meters between the mortar position and the target. This then is the range to fire the mark center of sector cartridge.

f. When he has determined the initial data by this method, the chief computer erases these plots on the plotting board so that he can now prepare it for use as a firing chart.

236. Targets Less Than 100 Meters Wide

Targets less than 100 meters wide are engaged with 1 or 2 mortars, depending on the width. To engage point targets, one mortar is usually sufficient. Converging or opening the sheaf of the section is not normally executed because it slows the delivery of fire for effect by necessitating individ-

ual corrections for each mortar rather than firing all mortars with the same data (parallel sheaf).

237. Adjustment of Parallel Sheaf

a. After the registration by the base mortar is completed, the computer directs the observer to adjust the sheaf. Although the mortars are laid parallel with a compass, the sheaf produced on the ground in the target area is usually not exactly parallel. This is caused by human error in using the compass, inability to calibrate the M4 sights with the mortar barrels, and the differences in the settling of the baseplates of the individual mortars.

b. There are two methods used in adjusting the sheaf. The method used depends on the location of the observer with respect to the mortar position-registration point line (whether angle T is more or less than 500 mils). (Angle T is equal to the difference between the azimuth, base mortar-registration point, and the azimuth, observer-registration point.)

c. Whenever possible, the computer selects an observer located near the mortar position-registration point line (angle T less than 500 mils). If both organic observers are located so that angle T is less than 500 mils, the one closer to that line is selected. Adjustment of the sheaf when the observer is well off the mortar position-registration point line (angle T more than 500 mils) is difficult, time consuming, and expends a large amount of ammunition. It is avoided whenever possible.

238. Adjustment of Parallel Sheaf When Observer Is Near Mortar Position-Registration Point Line (Angel "T" Is Less Than 500 Mils)

a. The computer issues a fire command to the section to fire a section right (or left) with the same adjusted deflection and range obtained by the base mortar. The observer sends back individual deviation corrections in meters for any burst that needs correcting to place it in the proper position in the sheaf. Using the mil formula

$$\left(M=\frac{W}{R}\right),$$

the computer changes these corrections in meters into mils. These corrections are then applied (LARS) to the deflection on the mortars. The mortars are relaid with this deflection. Another section right (or left) may be fired to recheck the sheaf if necessary. When a parallel sheaf is obtained, the computer notifies the gunners to refer all mortar sights to a common deflection and to realine aiming posts. This common deflection is the deflection for the base mortar to hit the registration point. The computer disregards small range errors when adjusting the sheaf. The range determined for the base mortar is used by all mortars in the section.

b. To adjust the sheaf parallel, the section fires a section right with all mortars using the firing data determined by the base mortar in the initial registration, a deflection of 2850 (aiming posts have been placed out on a referred deflection of 2800 mils), and a range of 1,200 meters. The observer's corrections are—

NUMBER ONE, LEFT THREE ZERO
END OF MISSION
SHEAF ADJUSTED

(1) Mortars No. 2 (base mortar) and No. 3—Since no correction was reported by the observer for these mortars, they are correct in the sheaf. The computer determines the correct deflection for mortar No. 1 as in (2) below.

(2) Mortar No. 1—The observer's deviation correction of LEFT THREE ZERO (in meters) is equal to left 25 mils at a range of 1,200 meters (using the deflection conversion table or the mil relation formula). The left 25 mils added to the deflection setting of 2850 becomes 2875 mils. The computer issues the command NUMBER ONE, DO NOT FIRE, DEFLECTION TWO EIGHT SEVEN FIVE, ELEVATION ONE TWO ONE SIX. The gunner of mortar No. 1 lays his mortar with the announced deflection. When the mortar is laid, the computer issues the following command:

SECTION
DO NOT FIRE
DEFLECTION TWO EIGHT FIVE ZERO
ELEVATION ONE TWO ONE SIX
REFER
REALINE AIMING STAKES

The gunner of mortar No. 1 refers his sight to a deflection of 2850 mils and directs the No. 3 man in his squad to realine the aiming posts. All mortars are

then laid parallel with a common deflection of 2850 mils. Thereafter, to fire a parallel sheaf on any target, each mortar of the section is given the same deflection, the deflection determined for the base mortar.

239. Adjustment of Parallel Sheaf When Observer is Well Off Mortar Position-Registration Point Line (Angle "T" is More Than 500 Mils)

The procedure used under this condition is described in FM 23–90.

240. Attacking Wide Targets

Targets that are wider than the effective front of the section parallel sheaf (90 meters) are not normally assigned to the mortar section because they require large amounts of ammunition. However, targets as wide as 300 meters can be engaged. When it is necessary to engage targets that are wider than the effective front of a section parallel sheaf, one of the following methods is used:

a. The parallel sheaf of the section is shifted successively to engage portions of the target (shifting fire).

b. The sheaf is opened and the individual mortars cover the target by traversing.

(1) *Shifting fire.*

(*a*) Shifting fire is accomplished by dividing the target into segments of approximately 100 meters and placing fire on each segment, one at a time. Shifting the fire of the section normally should not be done more than twice in engaging any one target. Overlapping fire on each segment is desirable. Therefore, targets between 100 and 200 meters wide can be engaged by shifting fire.

(*b*) The computer plots on the plotting board the point in the target area to which the OT azimuth was read. Adjustment on this point is made with one mortar to determine the correct range and deflection to the point. When the FDC plans to engage a target by shifting fire, often a flank mortar is used to adjust. In such cases, the point of adjustment may be the center or one flank of the target. (In computing firing data for other than the No. 2 mortar, the computer rotates the disk until the plot for each correction and the position of the particular mortar concerned are along, or the same distance from, the same vertical line.) After this adjustment, the computer indicates the limits of the target on the plotting board by orienting the board on the OT azimuth and drawing a line from the final adjusted plot to the right and left limits of the target (fig. 88). On this line representing the entire width of the target, he marks the dividing point between segments. The computer determines the firing data for the section to engage each segment of the target by using the data obtained for the adjusting mortar to each segment. After fire for effect is delivered on the first segment, the sheaf of the section is shifted to the second segment and fire for effect is delivered on that segment. The amount of shift to the second segment is determined from the plotting board or by the mil formula and may be given as total deflections; or, to speed delivery of fire for effect on the second segment, it may be given in number of turns of the traversing handwheel.

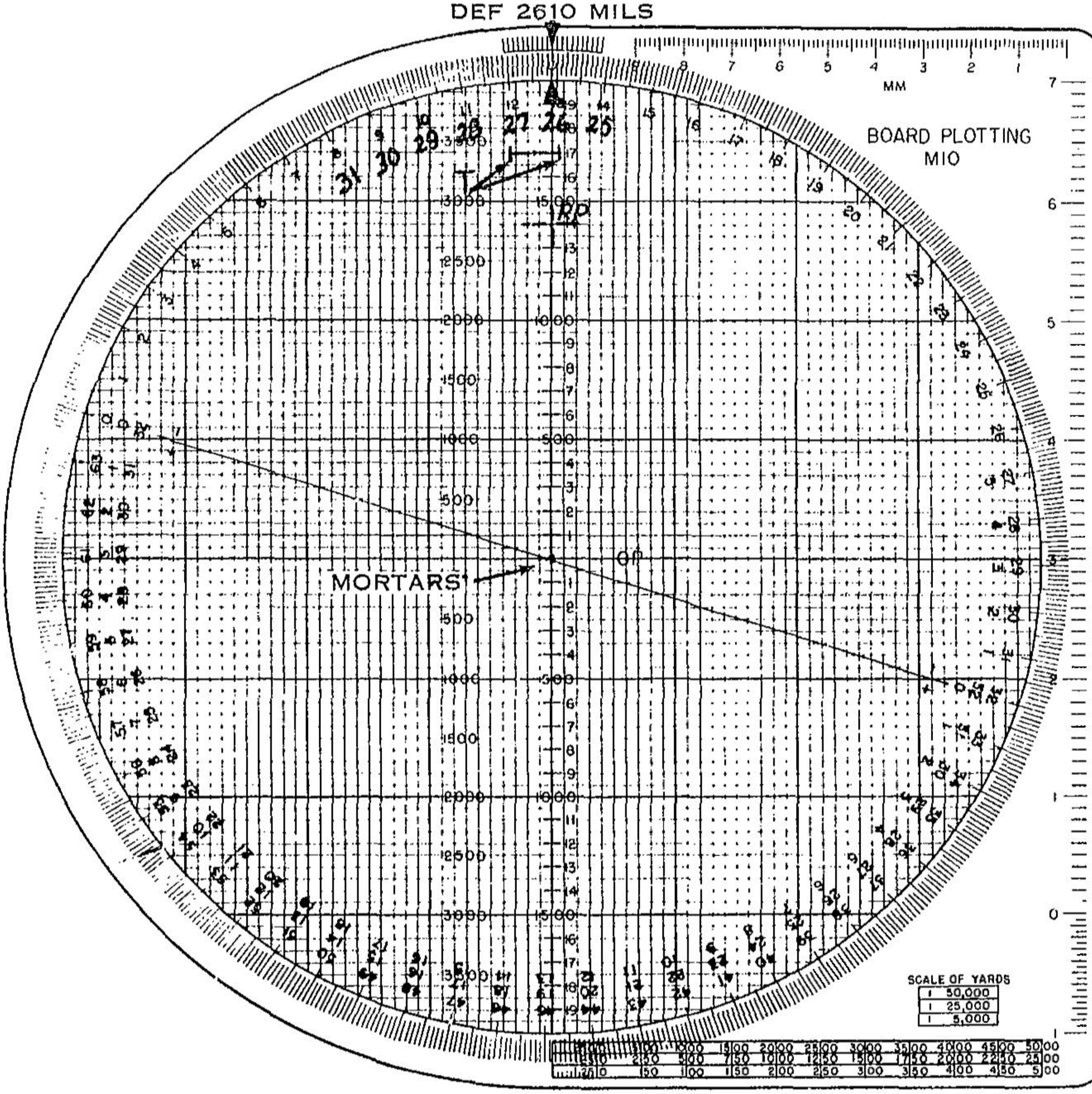


Figure 88. Section engaging a wide target by shifting fire.

Note. (fig. 88)

The section has been mounted on azimuth 1100, the registration point has been adjusted upon by No. 2 mortar with a deflection 2610 and at a range of 1,400 meters.

A call for fire is received in the FDC which calls fire on a target 200 meters in width.

Before plotting the wide target on the board, its center must be located accurately by adjustment. The computer decides to adjust mortar No. 1 on the center of the target (by doing this, fire for effect can be delivered on the left half of the target by using the firing data obtained by mortar No. 1 in its adjustment on the center of the target. Fire for effect can be delivered on the right half of the target using the firing data determined for mortar No. 1 to the right flank of the target. In each case, the parallel sheaf of the section will cover the segment).

Assume mortar No. 1 has been adjusted on the center of the target with a deflection of 2670 and a range of 1,700 meters. The computer now plots the target on the board.

The section fires for effect on the left half of the target with a deflection of 2670 and at a range of 1,700 meters.

To determine the firing data for fire for effect on the right half of the target, the computer rotates the disk until the point representing the right flank of the target is 30 meters to the right of the index line (assuming that

the mortars are 30 meters apart in the firing position). The firing data thus determined is a deflection of 2610 and a range of 1,700 meters.

The computer could shift the section to the right half of the target by shifting the sheaf right six turns.

$$M=\frac{W}{R}=\frac{100}{17}=60$$

or six turns (one turn of the traversing handwheel 10 mils).

Note. This figure shows the setting to obtain the data to engage the right half of the target.

(2) *Traversing fire.*

(*a*) Traversing fire is accomplished by dividing the width of the target into equal segments for each mortar. The sheaf is opened and each mortar is laid on the left (right) of its segment and all segments are covered by traversing the individual mortars to the right (left). Traversing fire by a section can be used to engage targets between 100 and 300 meters wide.

(*b*) The computer plots on the plotting board the point in the target area to which the OT azimuth was read. Adjustment is made with the base mortar to determine the correct range and deflection of the point. The computer then indicates the limits of the target on the plotting board by orienting the board on the OT azimuth and drawing a line from the final adjusted plot to the right and left limits of the target. On this line representing the entire width of the target, he places pencil marks to represent the desired location of the initial burst from each mortar (fig. 89). These marks are placed on the opposite side of each segment from the desired direction of traverse (to the left of each segment if the desired direction of traverse is right). He does this by dividing the width of the target into a number of segments equal to the number of mortars to fire for effect on the target. He numbers these marks 1, 2, and 3 to correspond with the mortars in the section firing position. To obtain the firing data for each mortar, the computer rotates the disk until the mark representing the desired location of the initial burst of the particular mortar and the position of that mortar are along, or the same distance from, the same vertical line. The deflection is read at the index. He determines the range for each mortar by referring to the range scale or by counting the squares between the mortar position and the plot of the desired location of the burst. If the range difference between flank mortars is less than 25 meters, the computer uses the range for the base mortar for all mortars. If time permits and ammunition is available, the computer may fire a section right (left) to check the sheaf as opened.

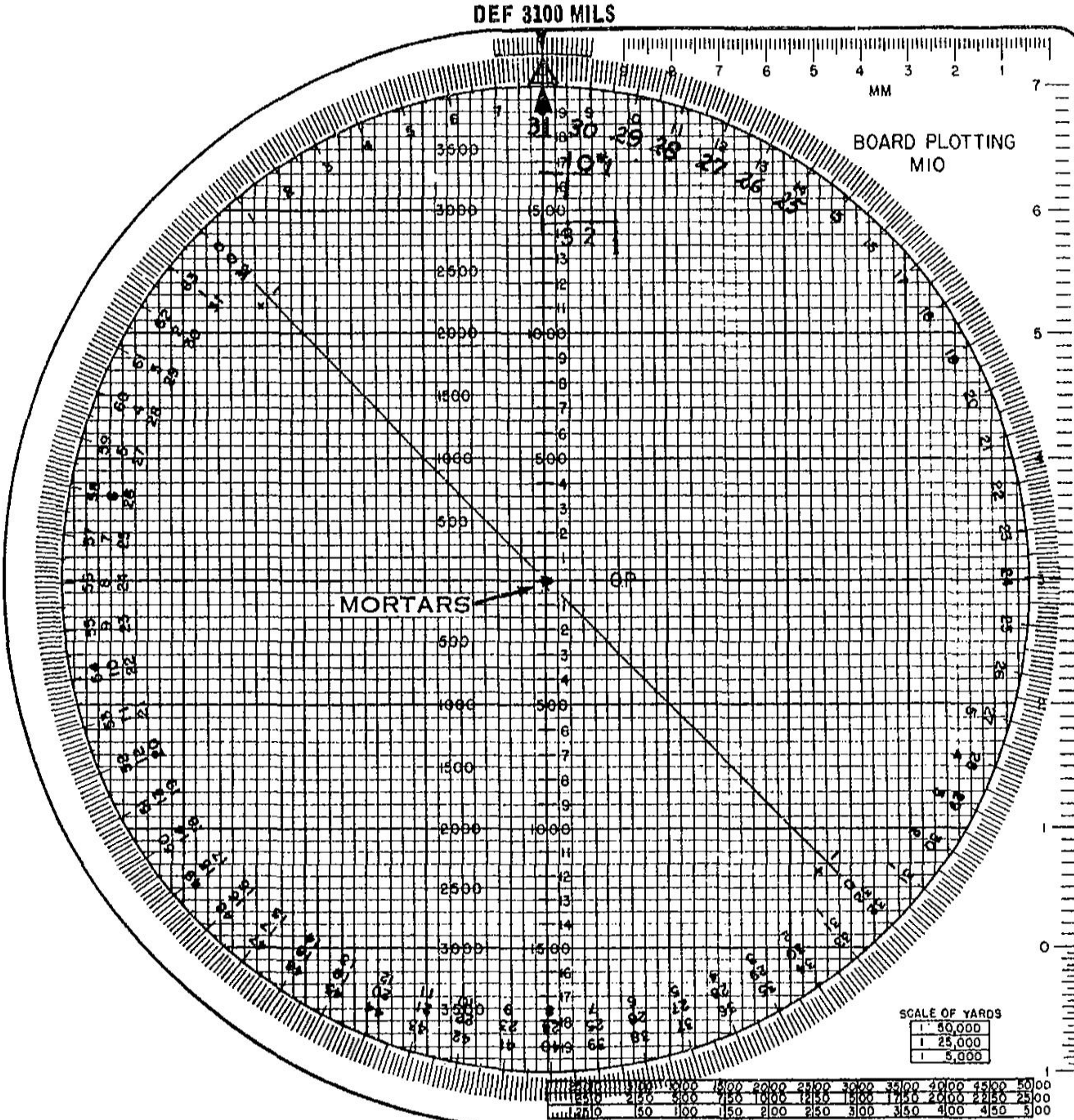


Figure 89. Section engaging wide target by traversing fire.

Note. (fig. 89)

The following call for fire is received in the FDC: OP TWO, FIRE MISSION, FROM TARGET ONE, DIRECTION EIGHT HUNDRED, RIGHT ONE HUNDRED, *DROP TWO HUNDRED*, TROOPS IN OPEN EXTENDING RIGHT ONE HUNDRED AND LEFT TWO HUNDRED METERS, FIRE FOR EFFECT.

Target No. 1 was adjusted upon by the base mortar (No. 2) on deflection 3040 and at a range of 1,650 meters.

No adjustment on the target is desired by the observer. The computer decides to fire four cartridges for effect with each mortar and to traverse left.

The computer plots the target on the plotting board, divides it into three segments, and plots the desired

location of the initial cartridge from each mortar. He determines the firing data by rotating the disk until the desired location of the initial cartridge for the particular mortar and the mortar position are along, or the same distance from, the same vertical line.

The computer determines the number of turns between cartridges for each mortar.

$$\text{As } 2\left(M=\frac{W}{R}=\frac{100}{1.5}\ (\text{approx})=65;\ \frac{65}{10\times 3}=\frac{65}{30}=2\text{ turns}\right)$$

He issues the following fire command:

SECTION
HE QUICK
NUMBER ONE, DEFLECTION TWO NINE ONE FIVE
NUMBER TWO, DEFLECTION TWO NINE SIX ZERO
NUMBER THREE, DEFLECTION THREE ZERO ONE ZERO
FOUR ROUNDS, TRAVERSE LEFT TWO TURNS, AT MY COMMAND
CHARGE THREE
ELEVATION ONE ONE EIGHT TWO

241. Attack of Targets 100 Meters in Depth

a. A section laid parallel with a 60-meter frontage, firing 3 cartridges from each mortar, can be expected to cover an area approximately 75 meters wide by 25 meters deep with casualty-producing fragments. By firing five or more cartridges from each mortar, this depth can be expected to increase to 50 meters due to greater dispersion. Targets that are more than 100 meters deep are not normally assigned.

b. Targets 100 to 300 meters wide that are 100 meters deep may be covered by opening the sheaf and assigning each mortar one-third of the target Each mortar then engages its portion of the target by—

(1) A series of traversing fires with 25 to 50 meters difference in range between each line of traverse.

(2) A series of searching fires with 30-meter intervals between each line of search.

242. Split Section Fire

a. When the mortars are operating independently or displacing (located in separate firing positions), a computer accompanies each mortar and operates an FDC for that mortar. The section may be located in three different mortar positions or in two positions (two mortars in one position area). In cases where the section is displacing, the chief computer should accompany the first mortars to displace in order to establish the section FDC in the new firing position.

b. When the mortars are located in a section firing position but have been assigned different sectors of fire, the chief computer computes firing data for one mortar, and the two computers determine firing data for the others.

c. When the mortars are located in three separate firing positions but have the same sector of fire, or when a portion of the sector of fire of each overlaps, the chief computer controls the fire of all mortars. When more than one fire mission is requested, the chief computer determines the priority of missions. When two or three fire missions are of equal importance, he assigns a fire mission to each mortar. Using a plotting board, he then computes the firing data for one mortar, and the computers determine the firing data for the others.

d. When the mortars are located in different firing positions but are under section control, one firing position may be plotted at the pivot point of the plotting board. The other mortars are plotted on the board using the firing data required to hit the registration point (or any other concentration already plotted), or using the survey data (azimuth and distance) from the first mortar already plotted on the plotting board.

243. Plotting Mortar Location by Survey (Azimuth and Distance)

a. When the azimuth and distance from a mortar already plotted on the plotting board to another mortar is known, the location of that mortar can be plotted. The computer rotates the disk until the azimuth from the mortar plotted on the plotting board to the other mortar is at the index. He plots the location of this mortar by counting up the range scale along the index line the distance determined between the mortars, and placing a dot at that point.

Example: In figure 90 the magnetic azimuth from the No. 2 mortar (plotted at the pivot point) to the No. 1 mortar is 2800 mils and the distance is 600 meters. The computer rotates the plotting board until the azimuth 2800 is over the index, counts up 600 meters from the pivot point, along the index line, and plots the position of the No. 1 mortar (fig. 91). He then pencils in the deflection scale for this mortar (in this case, mounted on a magnetic azimuth of 750 mils).

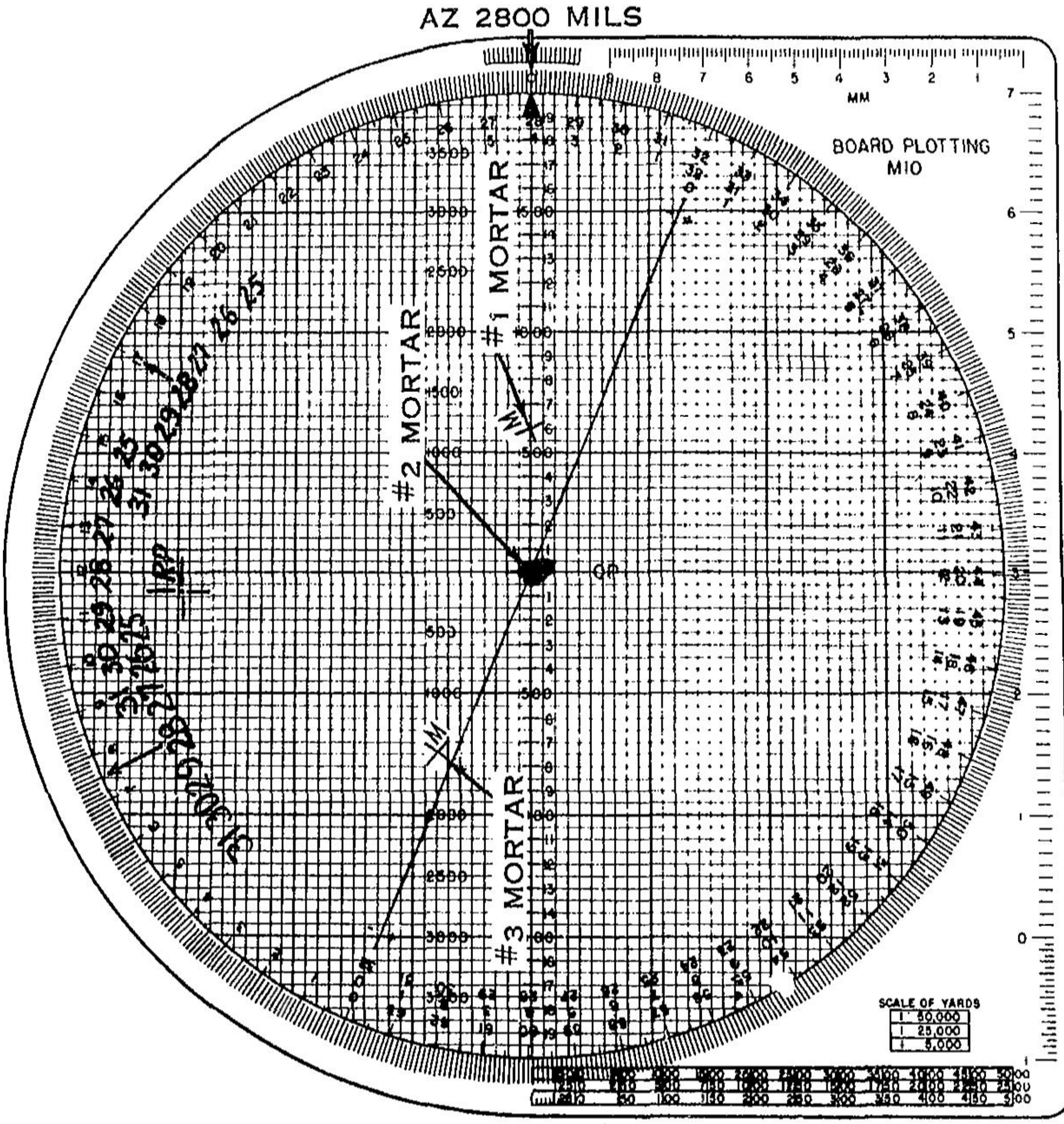


Figure 90. Plotting location of No. 1 mortar by survey (azimuth and distance).

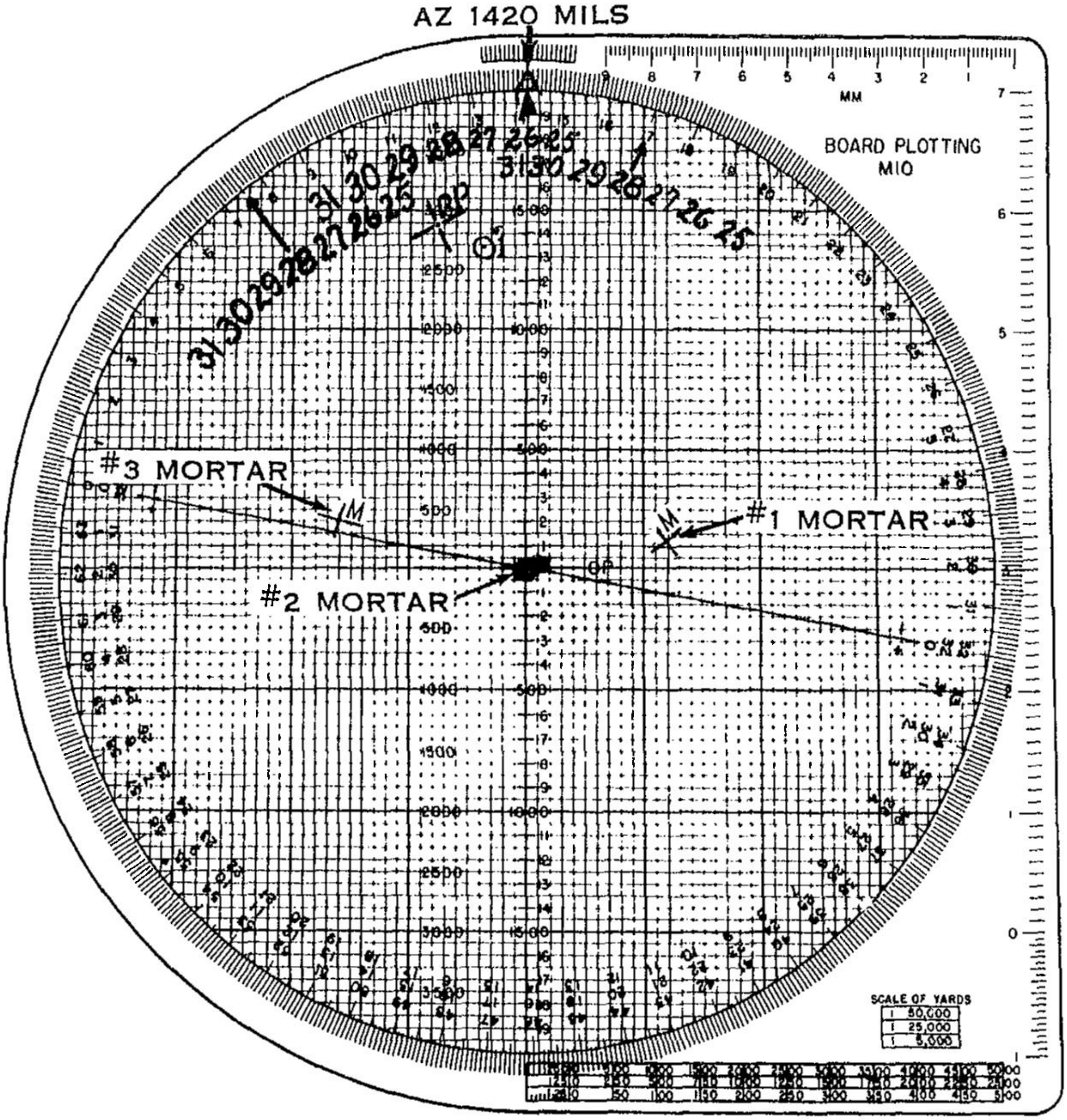


Figure 91. Plotting location of target.

b. When the final adjusted deflection and range for the No. 1 mortar to hit the registration point is not the same as was determined from the plotting board, the computer replots the No. 1 mortar firing position using the final adjusted data.

244. Alternate and Supplementary Positions

a. When time and the situation permit, the base mortar (No. 2) is moved to both the alternate and supplementary positions and is adjusted on the registration point, final protective fires (in the defense), and as many targets as possible.

b. When time or the situation does not permit such registration, the alternate and supplementary positions are surveyed in, with respect to the location of the base mortar at the primary position, by pacing on a compass (aiming circle) azimuth. The alternate and supplementary positions are then plotted on the plotting board.

c. Firing data can be determined from these positions to the registration point and targets which were fired upon by the unit while in the primary position. This is done by rotating the disk until the alternate (or supplementary) position and the target to be engaged are on the same vertical line (or the same distance from the same vertical line) on the base of the plotting board.

245. Prearranged Fires

Prearranged fires are fires for which detailed and exact data are prepared before their execution. They are used in the support of an attack or defense and for firing during periods of poor visibility or darkness. Prearranged fires may be unobserved fires. In the attack, especially in a fast-moving situation, the mortar section is limited in the amount of preparation which can be made to engage targets effectively. In the defense, however, detailed preparations can be made for the effective delivery of fire.

246. Target Areas in Defense

a. Target areas are assigned orally (by ground designation) or by overlay, map, photomap; or aerial photograph. These targets are known as final protective fires and targets. Examples of such targets are small areas not adequately covered by the final protective fires of other weapons, defiladed areas of departure for small units, and avenues of approach or communication.

b. Normally, each mortar is assigned one final protective fire (35 meters wide by 35 meters deep). That final protective fire is the squad's principal fire mission. The mortar is ready to fire on this target at all times and fires the final protective fire on signal or call from the fire direction center. Normally, a final protective fire is fired at near maximum rates for as long as required. A final protective fire may be repeated on call as often as required.

c. Targets are planned forward of the battle position to engage the enemy during his approach and attack, and within the battle position to limit penetrations and to support counterattacks. The section normally fires targets, although a squad (one mortar) may fire them.

d. Fire is adjusted on the registration point and the final protective fire areas when friendly troops are not situated in or dangerously near those targets. When time is available, fire is also adjusted on the targets.

247. Methods of Preparing Data in Defense

a. Firing data is prepared for each assigned sector of fire. When the section is employed as a unit, each squad is given the data to fire on its assigned final protective fire as soon as this data is prepared by the FDC. Data is normally obtained initially by range estimation and by the use of the compass at the observation posts. In some cases, initial data may be obtained from a map of aerial photograph. Upon occasion, it is practical to determine data may be obtained from a map or aerial photo- on the ground. Ranges and azimuths are obtained from maps and aerial photographs after accurately plotting the mortar position and the various targets. Initial data is confirmed by firing, if possible. If firing is for any reason restricted, adjustments are made in this sequence: registration point adjustment; final protective fire adjustment; and target adjustments. When adjustment is limited to the registration point, corrections obtained from the registration point adjustment are applied to data for the final protective fires and targets. Within range and deflection limitations, all mortars are prepared to fire on any of the final protective fires. Furthermore, as time is made available they are prepared to engage any target within range.

b. When possible, using the DA Form 2188–R (fig. 70), the prepared data is verified by firing.

c. Immediately upon assignment of target areas and a sector of fire, the FDC (or the squad leaders, depending on who is controlling the fire) prepares the DA Forms 2188–R. Since the DA Forms 2188–

R form a part of the record turned over to the relieving mortar crews and are considered a part of the special orders for a mortar position, they are prepared for alternate and supplementary positions as well as for primary positions.

d. When the section is employed as a unit, firing data is prepared for all targets (including the final protective fire for each mortar) and recorded on a single DA Form 2188–R. The base mortar is used to adjust on the registration point and to confirm the firing data for the targets. When possible, each mortar in the section is adjusted on its final protective fire. Each squad is given the data to fire its assigned final protective fire as soon as the data is prepared by the FDC. When a mission is not being fired, each mortar is laid on its assigned final protective fire. This is especially true at night or when visibility is poor.

e. When each squad is given a sector of fire, the computer accompanying the mortar, or squad leader, prepares the DA Form 2188–R for his mortar. To simplify the numbering of targets, each computer precedes his target numbers by the number of his mortar. For example, No. 1 mortar uses numbers 11, 12, 13, etc.; No. 2 mortar uses numbers 21, 22, 23, etc. A copy of the completed DA Form 2188–R for each mortar is given by the computer to the platoon leader or the chief computer.

248. Procedure After Preparing Firing Data

From the information on the DA Forms 2188–R, the FDC prepares a sketch (or over-lay when a map is used) showing the prearranged fires of the unit. The overlay or sketch includes the location of the primary, alternate, and supplementary positions, the sector of fire, the final protective fires, and targets (fig. 92). The FDC retains a copy of the sketch or overlay and sends a copy to the company commander. When an overlay is used, the actual location of the targets (crossroads, ravines, etc.) are plotted on a map, without regard to the adjusted firing data, and then transferred to the overlay.

249. Correction of Adjusted Data

a. Although a target has been adjusted upon once, it may be necessary to place different firing data on the mortar to hit the same target at a later date. This is caused by changes in weather and materiel.

b. This firing correction is determined by firing on the registration point (or other targets already adjusted upon). Both range and deflection are corrected. The correction factors—range and deflection—are applied when firing on any targets which have already been fired upon and for which data has been obtained. Readjustment on the registration point is made several times each day, particularly after any weather change, to determine the firing correction factors.

c. Techniques for determining and applying this data are covered in FM 23–90.

250. FDC Procedure in Use of Smoke, Time Fire, and Illumination

Although the fundamental principles of the target-grid method of fire control and the firing chart remain unchanged, certain additional considerations must be given to the conduct of smoke, time fire, and illumination missions.

a. Use of Smoke.

(1) If the call for fire for the screening mission indicates that an adjustment is necessary to locate one flank of the screen accurately, that adjustment is conducted. The sheaf is then opened on the plotting board as requested by the forward observer. To accomplish this, the computer indicates the limits of the target on the plotting board by orienting the board to the OT azimuth and drawing a line from the final adjusted plot to the right or left limit of the target area, as indicated by the observer correction. On this line, representing the entire width of the target, he places pencil marks to indicate the desired location of the initial burst from each mortar. Normally, the two flank mortars are designated to fire at the flanks of the target while the remaining mortar spaces the fire an equal distance from the flanks. Firing data for each mortar is then obtained by paralleling each mortar position plot with its respective target plot.

(2) The FDC may cause a section right (left) to be fired to allow the observer to adjust the rounds on the area to be screened and to confirm the wind direction and velocity. The FDC informs the observer of the method of engaging the target so that he will have a basis for corrections. From

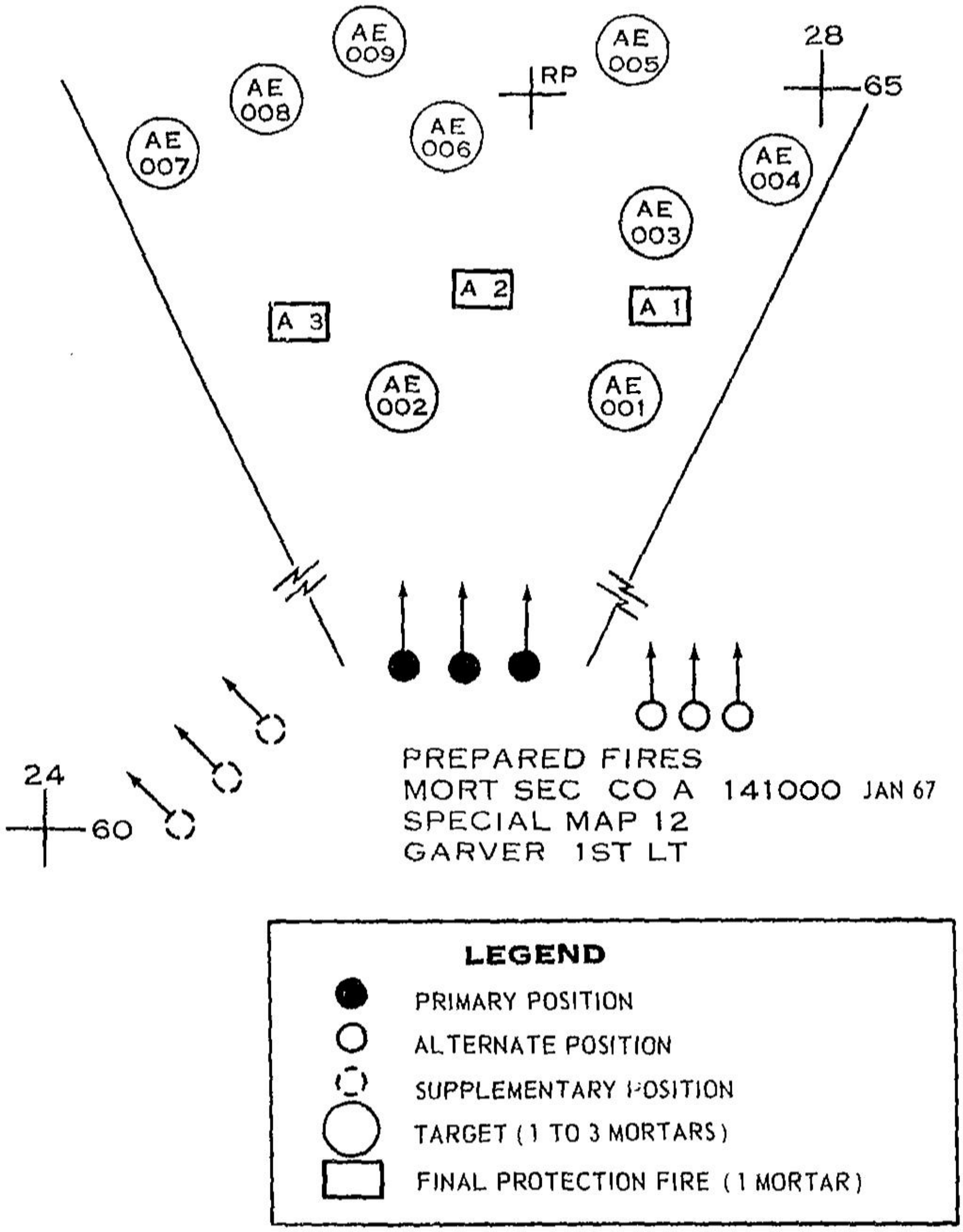


Figure 92. Mortar section overlay.

the available information, the chief computer decides the number of cartridges to establish the initial screen. The observer maintains the screen by requesting the necessary cartridges and by filling in any gaps which appear by sending individual corrections for the mortars. The computer converts these corrections in meters to mils of deflection and mils of elevation and sends them to the mortar position. Changes of data are applied so as not to break the continuity of the fire. (The correction may be sent in turns of the traversing handwheel and the elevating crank so as not to delay the mission by requiring the mortar to relay.)

b. *Use of Illumination.*

(1) The correct relative position of the flare to the target depends upon the wind and terrain. The point of burst is so placed as to give the most effective illumination on the target and to make sure that the final travel of the flare is not between the observer and the target. In the case of a strong wind, this necessitates placing the point of burst some distance upwind from the target so the flare drifts to the target location. Generally, the flare should be slightly to one flank of the target and at approximately the same range. When the target is on a forward slope, the flare is placed on the flank and at a slightly shorter range. For adjustment on a very prominent target, better visibility is obtained by placing the flare beyond the target to silhouette it and prevent adjustment on the target's shadow. When firing continuous illumination a strong wind may decrease the time interval between rounds. For maximum illumination, the flare is adjusted to burn out shortly before reaching the ground.

(2) The burst of the illuminating cartridge is adjusted only until it is within 200 meters of the target. The wind velocity and direction at the point of burst must be considered.

(3) After the FDC determines the direction and range at which to place the flare, firing table 60-L-2 is used to find the appropriate charge, and elevation.

(4) Two or more cartridges set to burst simultaneously should be used when observation conditions are poor because of range. Such a pair of cartridges fired from separate mortars permit better observation than two cartridges from the same mortar bursting at the same position. To illuminate a large area, cartridges properly located to cover the area should be fired simultaneously.

(5) The rate of fire for ideal continuous illumination is 1 cartridge per 10 seconds. This provides one round bursting, one halfway down and one just burning out. A rate of 1 cartridge per 25 seconds provides for 1 round bursting as the preceding burns out. Continuous illumination fire requires a large expenditure of ammunition which must be stocked prior to the mission.

(6) When the tactical situation requires, night adjustment of high explosive fire can be accomplished using the illuminating cartridges to aid observation. With one or more mortars providing continuous illumination of the target area, an FO can adjust the fire of other mortars on the target.

(7) The illuminating cartridge should not be fired to burst in rear of or above friendly forces except in emergencies. Such flares aid the enemy in observing our positions; in addition, each cartridge ejects parts which can produce casualties through free fall.

(8) For advanced techniques in the use of illumination, see FM 6-40 and FM 20-60.

259-386 O—67——11

APPENDIX B

REFERENCES

AR 320-5	Dictionary of United States Army Terms.
AR 320-50	Authorized Abbreviations and Brevity Codes.
AR 735-35	Supply Procedures for TOE and TDA Units or Activities.
DA PAM 108-1	Index of Army Films, Transparencies, GTA Charts, and Recordings.
DA PAM 310-1	Military Publications: Index of Administrative Publications.
DA PAM 310-3	Military Publications: Index of Doctrinal, Training, and Organizational Publications.
DA PAM 310-4	Military Publications: Index of Technical Manuals, Technical Bulletins, Supply Manuals, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
DA PAM 310-6	Military Publications: Index of Supply Catalogs and Supply Manuals.
FM 5-25	Explosives and Demolitions.
FM 6-40	Field Artillery Cannon Gunnery.
FM 7-11	Rifle Company, Infantry, Airborne, and Mechanized.
FM 20-60	Battlefield Illumination.
FM 21-5	Military Training Management.
FM 21-26	Map Reading.
FM 23-90	81-mm Mortar, M29.
FM 23-92	4.2-inch Mortar, M30.
TC 6-1	Field Artillery Observation.
TM 3-220	Chemical, Biological, and Radiological (CBR) Decontamination.
TM 9-1300-205	Ammunition for Mortars.
TM 9-1535	Ordnance Maintenance: Sights M4 and M6.
TM 9-1900	Ammunition General.
TM 9-3071-1	Field Maintenance: 60-mm Mortars M2 and M19; 60-mm Mortar Mount M5; 60-mm Baseplate M1; 81-mm Mortars M1 and M29; and 81-mm Mortar and Mounts M4, M23A1, M23A2, and M23A3.

APPENDIX B

FIRE CONTROL INSTRUMENTS

1. M2 Compass

The M2 compass (1, 2, and 3, fig. 93) is used to measure azimuths or angles of site. It measures magnetic azimuths or, when the instrument has been declinated for the locality, grid azimuths.

2. Description

The principal parts of the M2 compass are—

a. Compass Body Assembly. This assembly consists of a circular glass window which covers and keeps dust and moisture from the interior of the instrument. This protects the compass needle and angle-of-site mechanism. A hinge assembly holds the compass cover in position. A hole in the cover coincides with a small oval window in the mirror on the inside of the cover. A sighting line is etched across the face of the mirror.

b. Angle-of-Site Mechanism. The angle-of-site mechanism is attached to the bottom of the compass body. It consists of an actuating (leveling) lever located on the back of the compass, a leveling assembly with a tubular elevation level, and a circular level. The instrument is leveled with the circular level to read azimuths, and with the elevation level to read angles of site. The elevation (angle-of-site) scale and the four points of the compass, represented by three letters and a star, are engraved on the inside bottom of the compass body. The elevation scale is graduated in two directions. In each direction it is further graduated from 0 to 1200 mils in 20-mil increments, and numbered every 200 mils.

c. Magnetic Needle and Lifting Mechanism. The magnetic needle assembly consists of a magnetized needle and a jewel housing which serves as a pivot. The north-seeking end of the needle is white. On some compasses a thin piece of copper wire is wrapped around the needle for counterbalance. A lifting pin projects slightly above the top rim of the compass body. The lower end of the pin engages the needle-lifting lever. When the cover is closed, the magnetic needle is automatically lifted from its pivot and held firmly against the window of the compass.

d. Azimuth Scale and Adjuster. The azimuth scale is a circular dial geared to the azimuth scale adjuster. This permits the azimuth scale to be rotated approximately 900 mils in either direction. The azimuth index provides a means of orienting the azimuth scale at 0 or the declination constant of the locality. The azimuth scale is graduated from 0 to 6400 in 20-mil increments, and numbered at 200-mil intervals.

e. Front and Rear Sight. The front sight is hinged to the compass cover and may be folded into its bracket when not in use. The rear sight is made in two parts: a rear sight and a holder. When the compass is not being used, the rear sight and holder are folded across the compass body and the cover is closed.

3. Use of the M2 Compass

The compass should be held as steadily as possible to obtain the most accurate readings. The use of a sitting or prone position, a rest for the hands or elbows, or a solid nonmetallic support will help to eliminate unintentional movement of the instrument. When being used to measure azimuths, the M2 compass *must not* be near metallic objects.

a. To measure a magnetic azimuth—

(1) Zero the azimuth scale by turning the scale adjuster.

(2) Place the cover at an angle of approximately 45° to the face of the compass so the scale reflection will be viewed in the mirror.

(3) Adjust the sights to the desired position. Sight the compass by any of these methods:

(*a*) Raise the rear sight holder approximately perpendicular to the face of the compass. Sight on the object through

1. SIDE VIEW

Figure 93. M2 compass.

the opening in the rear sight holder and through the window in the cover. The compass is correctly sighted when it is level and when the black centerline of the window bisects the object and the opening in the rear sight.

(*b*) Fold the rear sight holder out parallel with the face of the compass, with the rear sight perpendicular to its holder. Sight through the window in the cover. If the object sighted is at a lower elevation than the compass, raise the rear sight holder as needed. The compass is correctly sighted when it is level and the black centerline of the window, the rear sight, and the object are alined.

(*c*) Raise the front sight and the rear sight perpendicular to the face of the compass (3, fig. 93). Sight over the tips of the rear and front sights. The compass is correctly sighted when it is level and the tips of the sights and the object are alined.

(4) Hold the compass in both hands at eye level with the arms braced against the body and with the rear sight near the eyes. For very precise measurements, rest the compass on a nonmetallic stake or other object.

(5) Level the instrument by viewing the circular level in the mirror and moving the compass until the bubble is centered. Sight on the object, look in the mirror, and read the azimuth indicated by the black end of the magnetic needle.

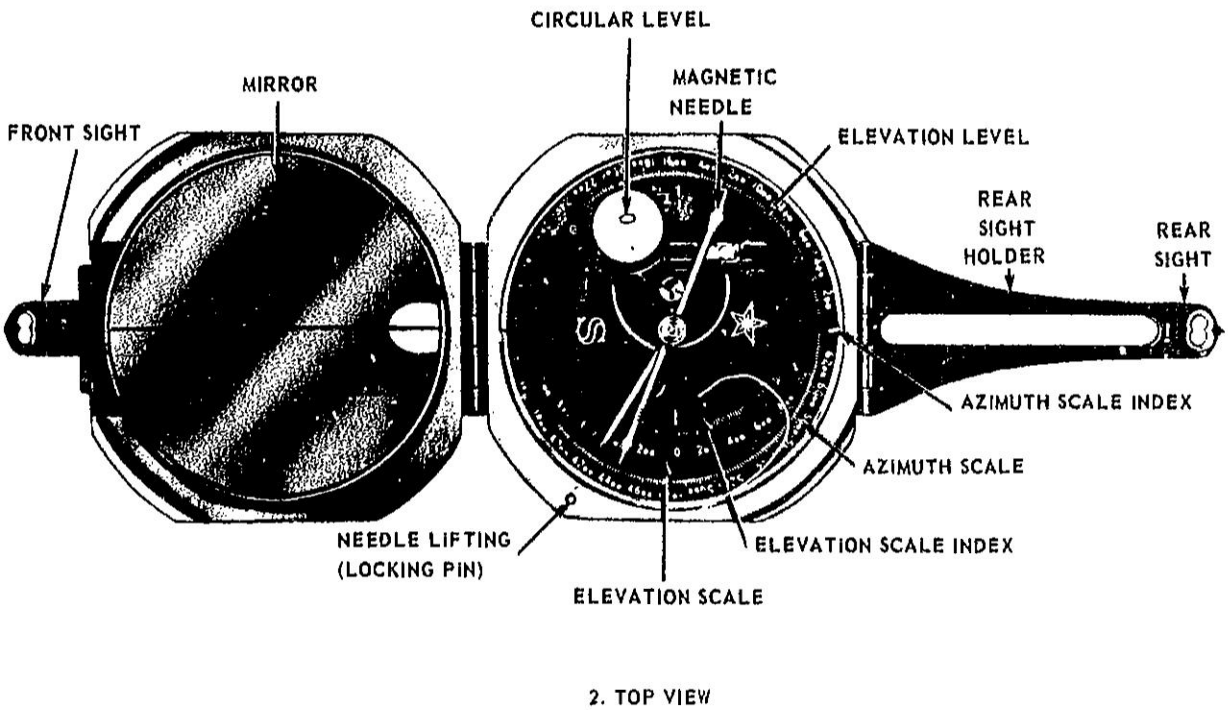
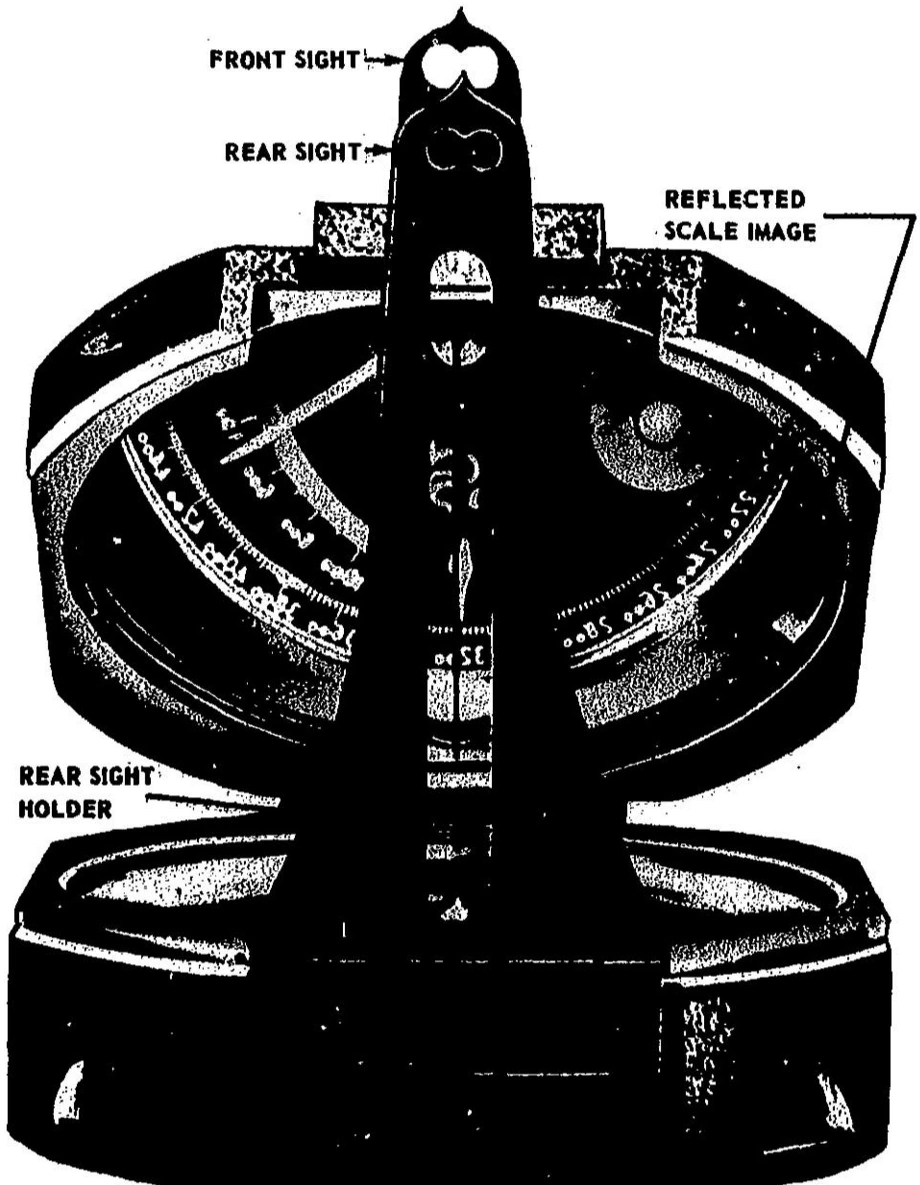


Figure 93—Continued.



3. USER'S VIEW, MEASURING AN AZIMUTH

Figure 93—Continued.

b. To measure a grid azimuth—

(1) Index the known declination constant on the azimuth scale by turning the azimuth scale adjuster.

(2) Measure the azimuth as described in *a*(2) through (5) above. The azimuth measured is a grid azimuth.

c. To measure an angle of site, or a vertical angle from the horizontal—

(1) Hold the compass with the left side down (cover to the left) and fold the rear sight holder out parallel to the face of the compass with the rear sight perpendicular to the holder. Position the cover so you see the elevation vial reflected in the mirror when looking through the rear sight and the aperture in the cover.

(2) Sight on the point whose angle of site is to be measured.

(3) Center the bubble in the elevation level vial (reflected in the mirror) with the level lever.

(4) Read the angle on the elevation scale opposite the index mark. The section of the scale graduated counterclockwise from 0 to 1200 mils measures plus angles of site. The section of the scale graduated clockwise from 0 to 1200 mils measures minus angles of site.

4. Lensatic Compass

a. Types. The lensatic compass is standard for use with the 60-mm mortar. Several models of this type are in service, all of which are quite similar. Other types include the prismatic compass and the watch compass. The watch compass is unsuitable for use as a fire control instrument.

b. Description. One type of lensatic compass is shown in figure 94. The carrying case is made of plastic. The hinged eyepiece contains a magnifying lens and is slotted on the end for sighting. The compass dial, pivoted in the center, is doubly graduated, the outer scale reading in mils, the inner scale in degrees. The compass is filled with oil, which dampens or slows down the movement of the dial, causing it to come to rest quickly. The hinged cover is slotted and contains a wire for sighting. This wire is marked at each end by a luminous dot. The crystal is movable and has a luminous line for use at night.

c. Use.

(1) The chief use of the lensatic compass in mortar units is to measure magnetic azimuths. It can be used as a marching compass.

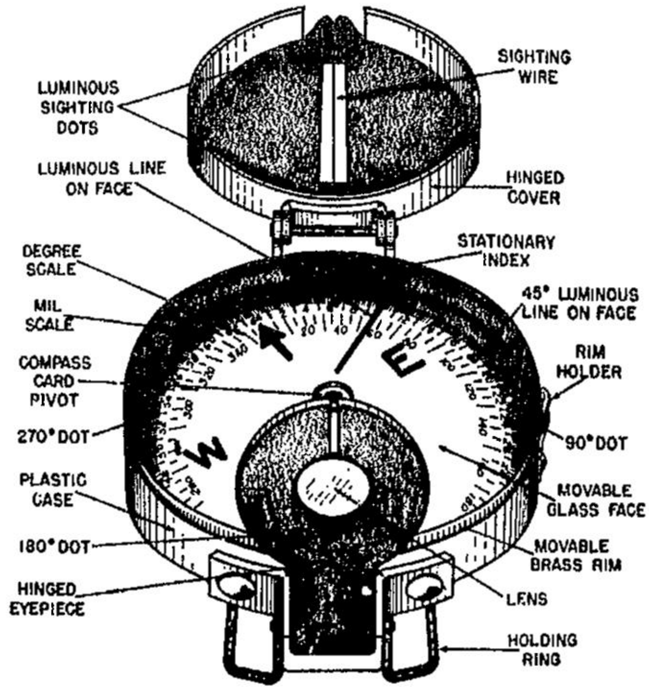


Figure 94. Lensatic compass.

(2) To take readings, place the compass on a level surface, when possible, or on a flat-topped aiming post. By using the holding ring for support, it can be read while held in the hand. Hold the compass with the dial as nearly level as possible to permit the needle to swing freely.

d. Operation.

(1) *To measure an azimuth*, raise the eyepiece and cover; sight through the slot in the eyepiece and the sighting wire on the cover. Rotate the compass until the line of sight bisects the object. Without altering the position of the compass, look through the eyepiece lens, and read the azimuth on the scale.

(2) *To determine back azimuth*, read the azimuth to the object. If the azimuth is less than 3200 mils, add 3200 mils; if greater, subtract 3200 mils.

(3) *To determine the horizontal angle between two points*, read the azimuth to each point and subtract the smaller reading from the larger. The difference is the

angle. In the event magnetic north lies between the two points, the resulting difference must be subtracted from 6400. The difference then will be the angle desired.

(4) *To lay off an azimuth at night*, place the compass under some type of shield (raincoat or shelter half), and use a flashlight or other light to illuminate it. Then turn the compass until the desired reading on the dial is opposite the stationary index. Move the luminous line on the crystal to coincide with the north arrow on the compass dial. Then, without using a light, move to the position from which the azimuth is to be determined. Hold the compass level and rotate it until the north arrow on the compass dial coincides with the luminous line on the crystal. The stationary index and the luminous sight dots on the hinged cover then point in the desired direction.

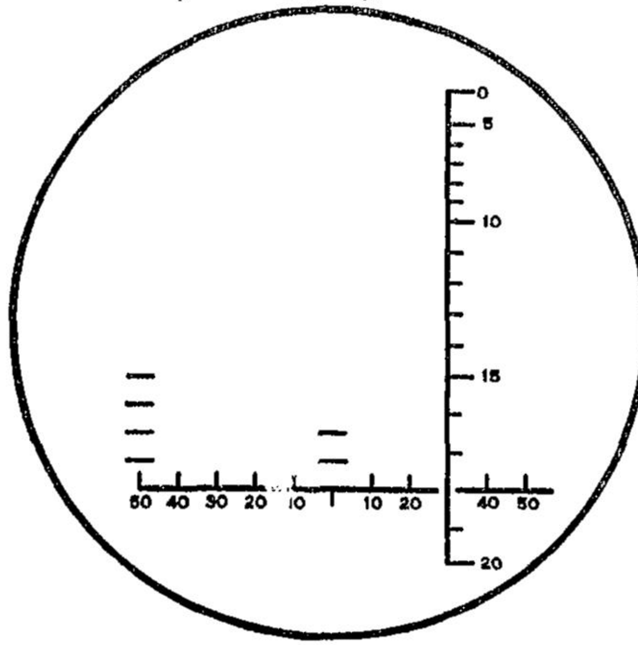
e. Care and Preservation. Although the instrument is strongly constructed, protect the needle pivot bearing and its jeweled support against shocks. To lock the needle, close the compass cover. Always close the cover when the compass is not in use.

5. Binocular M13A1

a. Description. The M13A1 is the standard binocular used for observation and approximate measurement of small angles (fig. 95). It has a six-power magnification and an objective pupil diameter of 30-mm. It consists of two compact prismatic telescopes pivoted about a hinge. This hinge permits the telescopes to be adjusted to the width between the observer's eyes. The left telescope contains the reticle.

(1) The reticle (fig. 96) has a horizontal mil scale graduated and numbered at 10-mil intervals from 50 mils right to 50 mils left of the center of the field of vision. Above the horizontal line are two series of reference marks. These marks are spaced 5 mils apart for convenience in observing fire. The vertical scale has no application to mortar firing.

(2) The neck strap, secured to the strap loops of the instrument, prevents accidental dropping and keeps the instrument within easy reach. A russet leather carrying case with a carrying loop and shoulder strap protects the instrument when it is not in use. The instrument is carried in the case with the eyepiece up. When replacing the binocular in the case, the diopter scale setting need not be disturbed but the hinge may need adjusting.



①

Figure 95. M13A1 binocular.

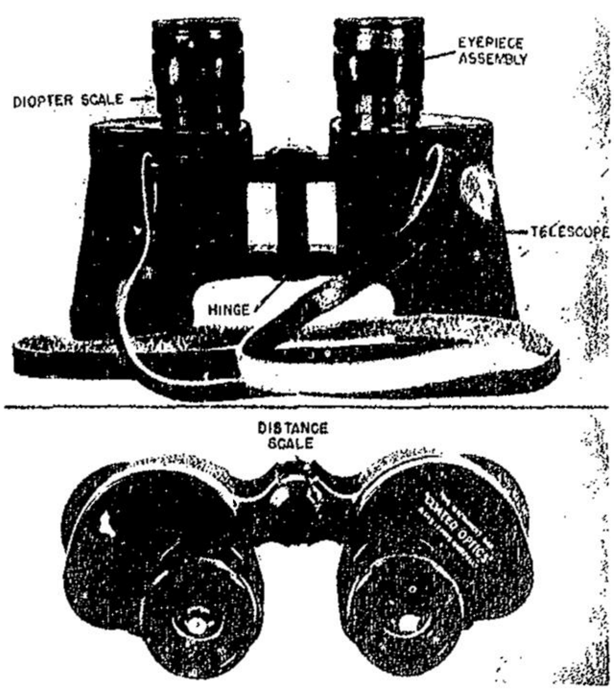


Figure 95—Continued.

b. Operation.

(1) *Setting interpupillary distance.* To set the binocular so that the eyepieces are the same distance apart as the observer's eyes, first look through the glass at some fairly distant object; then open or close the glasses at the hinge until the field of vision ceases to be separate or overlapping circles and appears to be one sharply defined circle.

(2) *Focusing.* Look through the eyepieces, both eyes open, at a fairly distant object. Place a hand over the front of one telescope and screw the focusing nut of the other in or out until the object is sharply defined. Repeat for the other eye. Then check the diopter scale reading on each eyepiece. This is helpful in making a similar setting on the eyepieces of other field glasses. Do not touch any optical surface.

(3) *Observing.* Hold the binocular in both hands, and press the eyepieces lightly to the eyes to avoid transmission of body tremors to the instrument. The hands may be cupped around the eyepiece and touching the face in order to eliminate light coming in between the eyepieces and the eyes. When possible, use a rest for the binocular or elbows.

(4) *Use of the reticle.* The mil scales are seen superimposed on the observed objects. The horizontal and vertical angles may be read from the mil scales.

c. Care and Preservation. The binocular is rugged in construction but do not subject it to rough handling. Do not disassemble or lubricate it, but refer all repairs involving disassembly or painting to ordnance. The binocular is resistant to moisture. However, during wet weather carefully wipe the binocular dry before returning it to the carrying case. Wipe the optical surfaces carefully with lens tissue paper.

6. Mil Scale Alidade

a. Use of Mil Scale Alidade on M10 Aiming Post. When the M10 aiming post is not used as an aiming post, the observer may use the mil scale alidade to obtain the initial direction of fire. He may also use the mil scale on the alidade to measure horizontal angles. To use the mil scale, which has a 200-mil field, the observer pivots the alidade at right angles to the post, tightens the wingnut, places the spike of the post against his cheek, and sights across the alidade.

b. Improvised Mil Scale Alidade.

(1) An improvised mil scale alidade (fig. 96) may be used to measure horizontal angles if the M13A1 binocular is not available. A scale placed on the alidade with approximately $\frac{3}{16}$-inch graduations measures 10 mils between markings when held 18 inches from the eye. A total of 400 mils may be measured with this scale.

(2) To fasten a cord to the alidade, place a hook at each end or drill two small holes through it. Place these holes 2 inches apart, with the 200-mil graduation halfway between the holes. Then insert the cord through the hooks or holes and tie it at a length so that when the cord is looped around the neck and drawn taut, the scale is 18 inches from the eye. When measuring a horizontal angle, place the zero of the scale on the burst or target, whichever is farther to the left.

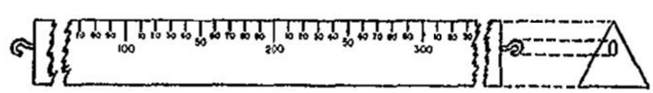


Figure 96. Improvised mil scale alidade.

INDEX

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
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